The Dock and Harbour Authority

No. 373. Vol. XXXII NOVEMBER, 1951 Monthly 1s. 6d

Editorial Comments

The Port of Gennevilliers, France.

The leading article this month is devoted to this comparatively unknown, but none the less important, transhipment centre situated on the outskirts of Paris, and known as the Port of Gennevilliers. The eminence of this port, which forms a natural link between inland water and rail transport, is seemingly assured by its favourable geographical position; indeed, as the author observes, on a tonnage handled basis the " Port of Paris," as it is popularly called, has held in past years a place in the front rank of all French ports. Since the Second World War, however, this position has not been retained, and the article which follows sets out the reasons for the decline, the considerations which led to the selection of Gennevilliers as the site for new developments, a description of the works already put in hand, and details of the future plans of the Seine Departmental Assembly.

It is interesting to recall the project that became popular in the years before the 1914-1918 War under the name " Paris, a Sea Port," but the increased size and draught of vessels has reduced to very modest proportions the great plan of the engineer, Bouquet de la Grye. Nevertheless, despite the dislocations and setbacks of two world wars, the idea, in principle, has persisted, and the present scheme is a step towards the ultimate goal of bringing to Paris, when the Seine has been deepened to five metres, sea-going cargo boats, specially built to pass beneath the bridges, and having a dead-weight capacity of up to 1,500 tons.

In the meantime, it is contemplated that an appreciable volume of transhipment will take place at le Havre from ocean-going vessels to river craft, but for through traffic, the author mentions certain existing French and English coaster vessels, and the Dutch vessels that are ubiquitous in North Sea and English Channel ports, and the North European canals, and can ascend the River Thames above the bridges. As an indication of what can be accomplished in designing vessels for special navigational requirements, we would call attention to the colliers which regularly ply between North-East Coast ports and the power stations and gas works situated on the Thames, as far inland as Fulham and Wandsworth. These vessels carry upwards of 3,000 tons of coal, and their daily voyages without accident represent a triumph of both shipbuilding and navigation in a tidal river with currents and bridges presenting hazards far greater than anything likely to be met with on the River Seine.

The new port works now in hand at Gennevilliers are of considerable interest. Firstly, the layout of the new inland port with its basins, roads, railways and connections gives a good example of a planned arrangement with no physical or other restrictions to mar it, and thus it is, in the view of the designers, the best layout for the purposes required.

With regard to the quay walls, it will be noted that the original block construction, completed in 1939, has given place to quay structures of the reinforced concrete platform type, provision being made in the design for an ultimate depth of water alongside of five metres. In the projected eastern wall of Basin 2, it will be observed that the width of the slab and the number of piles will be reduced, thus effecting a saving in cost while still providing a quay of ample stability for the depth of water and conditions involved.

The water testing of a 30-metre length of quay wall, i.e., between two expansion joints, is an interesting innovation, and while the deformations both horizontal and vertical were very small, the results confirmed that, under the trial conditions, large negative movements were set up in the crossbeams connecting the pile heads.

The Port of Gennevilliers is essentially a co-ordinating link between waterways and railways, and this accounts to a large extent for the predominant railway facilities on the merchandise quays. At the same time, the coal and oil and grain installations are of some importance.

The current collecting system of the cranes is worthy of special mention, and readers will be interested to learn that the layout of the quays with loading platforms was only decided upon after much discussion, the alternative being two rail tracks only, on the edge of a quay spanned by gantry-cranes and having sheds without platforms. Inside the sheds, there are no travelling-cranes, all horizontal movement of cargo and piling being done by fork lift trucks.

We agree with the author when he says that a modern port system is being created, worthy of the first city in France, and we wish the management and staff every success in the future.

Pre-stressed Concrete.

Pre-stressed concrete has become a most important new medium in structural and civil engineering, and there are many maritime works subject to the action of sea-water where, in due course, its application may be particularly efficacious.

At the present time, this form of reinforced concrete is in its infancy, and as frequently happens at the outset with new techniques of construction in civil engineering, research and practice are proceeding together. In fact, most progressive engineering structures contain some feature which is more or less experimental, or some particular difficulty is overcome by novel methods.

Editorial Comments—continued

In this respect they themselves may be regarded as being in the nature of research, as they usually provide data for further investigation or object lessons for the future.

On a following page we reproduce, by kind permission of the Institution of Gas Engineers, the first instalment of a Paper upon the application of pre-stressed concrete to general building work. The author briefly reviews the history, general principles and advantage of this medium, and then gives some examples of handling, driving and testing piles made on the Hoyer bonded wire system. He follows with informative details of impact tests on pre-stressed concrete piles intended to act as fenders. This is a use for which the flexibility, resilience and impermeability of a pre-stressed member would seem to be particularly applicable, and it is hardly necessary to point out the further possibilities in respect to pre-stressed concrete jetties, dolphins and similar maritime structures, where such qualities are extremely desirable.

To those who are newly approaching the art of pre-stressed concrete design, we would point out that this is not so involved as some text books on the subject would seem to imply, and no student need be deterred from applying himself to a close study of a technique which holds such promise for the future. While it is agreed that, at the present stage of development, it would be inopportune to establish a code of practice, nevertheless, a universally acceptable notation, including the use of the metric system, would be a useful means of simplifying the co-ordination of international research, and would help in the examination of theories put forward or of works constructed at home or abroad.

Projected Contour Canal

In the June, 1942, issue of this Journal, we published a review of a book by Mr. J. F. Pownall, presenting the case for a single level canal throughout the length and breadth of England, and in the following issues appeared certain correspondence which the project evoked. We are now printing an article by the same writer in which he discusses the possibilities of constructing a part of his proposed Grand Contour Canal, with the primary object of increasing the water supply of London.

London is not only the chief commercial centre, but also the largest industrial nucleus in Britain, and the urgent necessity for augmenting water supplies is causing serious concern.

After periods of low rainfall the rivers Thames and Lea, from which the principal supplies of water are drawn, are unable to meet the demand, whereas in the winter months, in the Thames particularly, an excessive rainfall causes extensive floods. Any suggestion therefore which has the possibility of regularising the flow of water in the Thames, and making available additional water supplies to London, is worthy of examination.

It is well known that, owing to the physical characteristics of the British Isles, the high lands of the north-west, west, and south-west, provide an excess of effective supply of water over that of the eastern areas, and as far as the water supply of London is concerned, it is apparent that the nearest source of any great increase is the Welsh hills. A large proportion of the water from that region, however, falls into the tributaries of the Severn, and thence to the sea.

Readers will observe that one of Mr. Pownall's schemes embraces an intake from the Severn, involving pumping and pipe lines through the physical barrier of the Cotswold Hills, and thence into the projected contour canal, and further pipe lines to the Grand Union Canal reservoir at Aldenham; the other part of his scheme, relating to the catch-water aspects of the Cotswold and Buckingham sections of the Canal, are outlined in our Editorial Foreword to the article, and need not be mentioned here.

We are not in a position to confirm or question the geological data upon which the water supply aspects of the catch-water scheme are based, but it is obvious that details of the rate of percolation, and the quantities of water which could be absorbed, could only be obtained from systematic investigation and experiment in the field. We would remark, however, that the Severn intake must not tap saline water, and the practicability of obtaining bulk supplies from that river would require prolonged investigation. Moreover, it would seem preferable for bulk supplies from that source to be discharged into the Thames, preferably below Oxford, or into the River Lea, so as to take advantage of the existing storage and service reservoirs of the Metropolitan Water Board.

Another aspect of the water supply of London not specifically mentioned in the article, is the gradual lowering of the underground water table in the chalk, and the sands above the chalk. This is largely due to deep wells and to overpumping in certain areas and is accompanied by infiltration of salt water.

There might be a possibility of leading some of the surplus water from the Thames, kept full perhaps by means of one or other of Mr. Pownall's schemes, to soakaways in the chalk where the river passes over it. This, of course, would be a complete reversal of the present policy of Catchment Boards, who seek to pass all surplus water, in times of flood, down the rivers to the sea.

The problem of water supply is none the less acute in the Eastern Counties, but to pursue these matters further is admittedly not within the scope of the present article. Readers, however, who are specially interested should study among other works on the subject, a paper by Dr. Stevenson Buchan entitled "The Work of the Water Department of the Geological Survey," which was recently read before the Institution of Sanitary Engineers. In addition, Dr. C. B. Fawcett's article, "Increasing London's Water Supply, which appeared in the February, 1950, issue of "Water and Water Engineering," advocates obtaining water supplies from the Severn on somewhat similar lines to those proposed by Mr. Pownall.

Whether the water supply aspects of the proposed schemes are feasible or not, is a matter for geologists and water engineers. They appear, however, to contain some suggestions which might be developed by those capable of giving the proposals expert consideration, and although the author's analysis of the economics of the project (and in particular the pumping and maintenance costs) are not identical with our considered opinion, nevertheless the article should stimulate interest in some of the principles involved and discussed.

Colonial Harbours and Wharfs.

In this issue will be found excerpts from the Discussion on Mr. Gwyther's Paper on Colonial Harbours and Wharfs, the first and second instalments of which appeared in our September and October numbers.

As a general rule, the subsequent discussion on a Paper provides useful additional data, information and comment and the present case is no exception. We would call particular attention to the remarks of several speakers giving their reasons for the choice at Colonial ports of single and, alternatively, two-storey sheds. The arguments for and against solid block quay walls, and details of the relative costs of this type compared with the alternative open piled flat slab wharf, also provide some interesting aspects, worthy of attention.

Again, various figures are discussed in regard to the amount of general cargo handled per linear foot of quay per annum, and, as will be seen, in most cases the volume varies between wide limits. The part played by lighterage at many Colonial ports is shown to be greater than might at first be expected, and it is evident that this method of cargo handling is still of great importance. The whole of the discussion reproduced is deserving of careful study.

Increase in Subscription Rates

The Publishers of "The Dock and Harbour Authority" regret to announce that, owing to substantial increases in the price of paper, printing, postages and overall production costs, it has been found necessary, for the first time since the Journal was founded in 1920, to increase the selling price to 2s. per copy plus 4d. postage. The annual subscription will be 26s. 0d., including postage to any part of the world, and the new charges will take effect as from 1st January, 1952. Current subscriptions will continue at the old rate until due for renewal.

The Port of Gennevilliers, Paris

Its Reconstruction and Projected Extension for Maritime Traffic

By M. J. GUEYDON DE DIVES*
(Chief Engineer of Bridges and Highways)

THE DOCK AND HARBOUR AUTHORITY has already printed in its August, 1950, issue, an account of the opening of the Port of Gennevilliers on the 10th July of that year. I would like to thank the Editor for allowing me to publish this more extensive review of the Port and thus to make this knowledge available to his many readers both in Great Britain and throughout the world.

I. Origin and Description of the Project.

The city of Paris and the suburbs which surround it constitute the Department of the Seine, with a total population of 5,000,000, one of the most thickly populated districts in the world. Since the earliest times, the Seine and the Marne have provided the livelihood and the means of export for the population of Paris. During the nineteenth century, under the influence of Napoleon, the Canals of St. Denis, St. Martin and l'Ourcq were constructed, and it became customary to describe the collection of private and public establishments spread out on either side of these navigable waterways as "The Port of Paris." The Seine, the Marne and the above mentioned Canals cover a total length of about 110 kilometres.

The importance of this port continued to increase until the years of crisis preceding the outbreak of the First World War. In 1913 and in 1931, the tonnage of goods loaded and discharged along the length of the navigable waterways of the Department of the Seine attained the record figure of 16,000,000 tons which placed this port in the front rank of all French ports. Yet at present the river traffic of the Port of Paris shows a decline; although in 1938 it led the country with a tonnage of 13,000,000, since the end of the Second World War it has occupied only about fourth place with some 8,500,000 tons of cargo handled.

In order to meet the demands of both road and rail traffic, the Port of Paris has not in fact enough equipment and storage space on the public quays, and above all it has not enough ground available further inland upon which warehouses can be built, and where industries can be established which will become the clients of inland navigation. Remaining a port of consumption, it has not become the main national transhipment centre between water and rail transport, a function to which it is predestined in view of its remarkable geographical position. It now remains for the Port to extend its direct maritime connections between the Paris district and foreign countries, which can be attained by two methods, namely: by means of small shipments, being a modest and modernised version of the original grandiose project of a sea port at Paris, or by the development of transport at high cost either through Le Harve or through Rouen.

The General Council of the Department of the Seine is well aware that the widely dispersed installations of the Port of Paris are inadequate for it to become anything more than a port of consumption. That is why, since 1926, it has obtained a declaration of public utility for the establishment of a new modern port which will include the following functions: an industrial port; a transhipment port; and an export port for handling foreign cargoes.

The curve of the Seine at Gennevilliers has been selected as the site for the new port, because it has the following remarkable advantages, namely: it is close to consuming industries, mainly situated in the north and west of the Paris district. Being downstream from Paris it will receive the greater part of the traffic from the lower Seine and from the Oise; by stopping at Gennevilliers the traffic coming from the lower Seine achieves an economy of 35 kilometres, including one lock and 40 bridges. There is enough area available for the construction of large embankments both for the storage of goods and for accommodating industrial establishments. Moreover, the site offers excellent facilities for railway connections.

Furthermore, it is believed that the Port of Gennevilliers will ease the crossing of Paris and will contribute towards the future growth of traffic. It will also facilitate the movement of unpleasant or dangerous industries towards the suburbs, such as those associated with gasworks and refineries. It will also have the effect of localising a region in which industry and population can be rapidly developed. The port will extend over an area of 390 hectares, bounded on the north by the Seine, on the west by the tracks of the Paris-Argenteuil railway, on the east by the lines from St. Ouen to Eaubonne, and on the south by the future National Road No. 186.

There will eventually be six basins varying in length from 500 to 800 metres, connected to the Seine through two channels. The total water area will be about 45 hectares and will be comparable with that of the Port of Dunkirk. The basins will have a width of between 70 and 90 metres, the entrance channels will be 65 metres wide and they will be orientated in the downstream direction in order to facilitate the movement of shipping coming mainly from the lower Seine and from the Oise. The total length of mooring quays will be about 12 kilometres and the mooring depth in the basins will be about 3.20 metres, but all the works will be constructed with the object of allowing the mooring depth to be increased to 5.00 metres by simple dredging when the Seine has been dredged to this depth between Rouen and Gennevilliers.

The embankment behind the basins will be finished to a minimum level of 27.59, or 4.40 metres above the normal level to which it is necessary that they should be constructed in order to be above maximum flood level. The flood of 1910, the highest recorded on the Seine, rose to 28.59 at the entrance of the west channel of the port; it is estimated that to-day a similar flood, in view of the works which have been carried out, would only reach to about 28.20. Since 1910, the flood of 1924 reached the level 27.95 and that of 1945 the level 27.70.

A very complete road system will ensure intercommunication between the works and an arterial road 30 metres wide and 3,500 metres long will link together the docks. It will be the main road of the port to which all other roads will be connected, and it will serve at the same time as a defensive dam against the onslaught of an exceptional flood. It will be joined on the west to National Road No. 309 from Paris to Argenteuil, and on the east to National Road No. 310 from Paris to Epinay. Each dock will be served by several railway tracks, and when the port has developed to a sufficient extent, a large shunting yard will be constructed along the embankments to the south of the main road.

II. Progress of the Works—Port Works.

With the exception of some areas bordering on the southern limit, the Department of the Seine is the owner of the entire port site. Ground which is irrigated by flood waters was leased to farmers until it became of value to the port authorities. At the beginning, work went ahead rather slowly. In 1939 the port had available the two basins, Nos. 1 and 2, the left bank of Basin No. 1 being provided with a quay wall 500 metres long, while a protecting wall was built for a distance of 800 metres along the steep bank of the Seine.

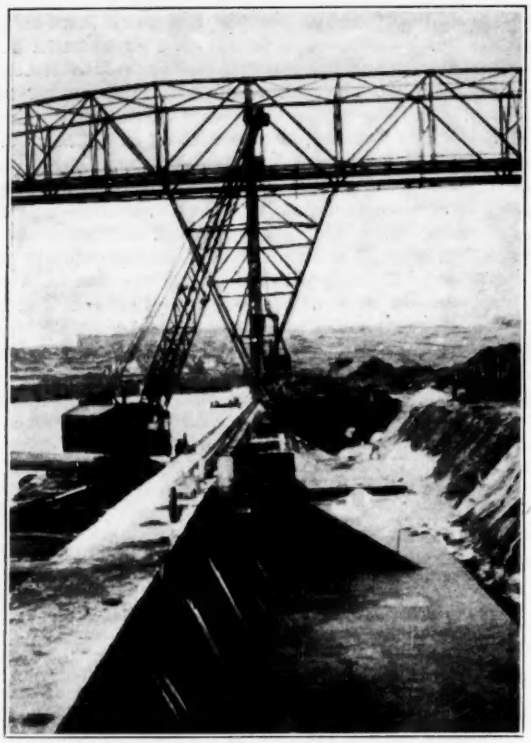
Between 1940 and 1946, part of the port property passed successively from the Germans to the Americans, then to the National Society for the Sale of Surplus Property after the liberation. These occupations have hindered liberty of action but at the same time

*Translated from the French for *The Dock and Harbour Authority* by Rolt Hammond, A.C.G.I., A.M.I.C.E.

The Port of Gennevilliers, Paris—continued

they had the advantage of providing certain improvements, such as warehouses and sidings which have been of great benefit to the port.

In the welter of ideas which followed the Liberation, renewed interest was displayed in the project of the Port of Paris and the slogan, "Paris, A Sea Port," became popular. It was at this period, as if making an echo, that the Seine Departmental Assembly obtained from the Ministry of Public Works a decision establishing



Right bank of the quay at Basin No. 1 during construction. The concrete slab is supported by reinforced concrete piles and the capping beam supports the running rail of a coal transporter.

a clearance of 7.00 metres above the highest navigable water for the bridges of the lower Seine between Rouen and Gennevilliers. The Technical Directorate of the Port of Paris profited on its side from this favourable trend in order to press forward once again the claims of the Port of Gennevilliers.

The Port of Gennevilliers is not a State port, the State having merely issued a "public utility" decree and not having, so far, given any subsidy for works. Nor is any concession granted by the State to the Department of the Seine which is normally responsible for the construction of foundations and sub-structure, for highway and railway construction and for basins and embankments. It is the Technical Directorate of the Port of Paris, under the authority of the Prefect and General Council of the Seine, which directly manages Gennevilliers. This Directorate constructs the substructures, while the Chamber of Commerce of Paris is responsible for mechanical equipment and for warehouses of the public quays.

Sub-structure.

Basin No. 1. This was started with a width of 90 metres and a depth of 3.20 metres. The quay on the left bank, built just before the war, is a solid maritime type of work but expensive. The quay on the right bank, now in course of construction, consists of a reinforced concrete slab supported by piles upon which is supported the side wall. Horizontal thrusts have been taken by the inclined piles. Tests of the resistance of the work to horizontal thrust were carried out by hydrostatic means as shown in the accompanying photograph. The deflections measured by the Bureau Veritas were extremely small, the rear portion being practically buried in the ground.

Basin No. 2. This was started with a width of 70 metres and a depth of 3.20 metres. As yet it has no quay, except some booms on the right bank. It will probably not be constructed as a vertical quay like that of Basin No. 1; the plan envisaged is a compromise between a sloping wall and a vertical quay as shown in the drawing. This design is convenient for portal cranes and also provides for the maximum possible use of mobile cranes; the cost was about half that of the previous work.

Basin No. 5 and Basin No. 6. The latter is reserved for dealing with oil cargoes, and both these basins are being constructed to a width of 70 metres and a depth of 3.20 metres. The Seine, controlled by sluices, is a river with a very feeble current which presents no problem of dredging or accretion. However, the banks and certain points in the basins are protected by masonry pitching.

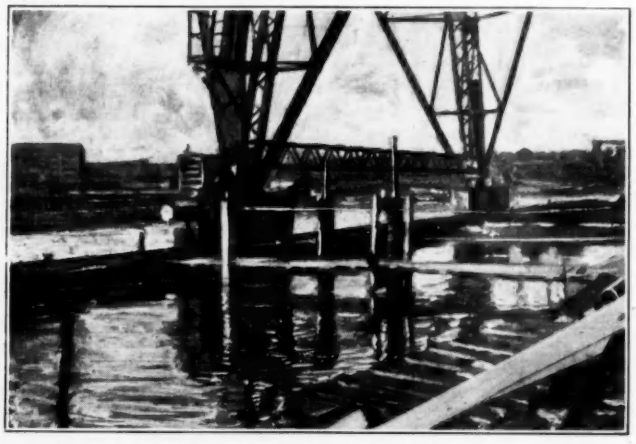
The ground level in the Port has been raised by embankments to a height greater than that reached by the highest floods, and the excavated material from the basins has been used for making these embankments. The embankments at this port provide an excellent solution to the problem of disposing of large quantities of ashes from power stations; the Gennevilliers Power Station of 300,000 kW. simply discharges all its ashes to the port, where they are transported to the point of dumping through a pipe line mixed with water.

Equipment of Public Quays.

The Chamber of Commerce of Paris is responsible for equipping the quays to deal with general traffic. The equipment on the right bank of Basin No. 2 is part of a forthcoming programme. A certain amount of development is being undertaken with motor-driven shunters, of which the port has a dozen in service of various sizes.

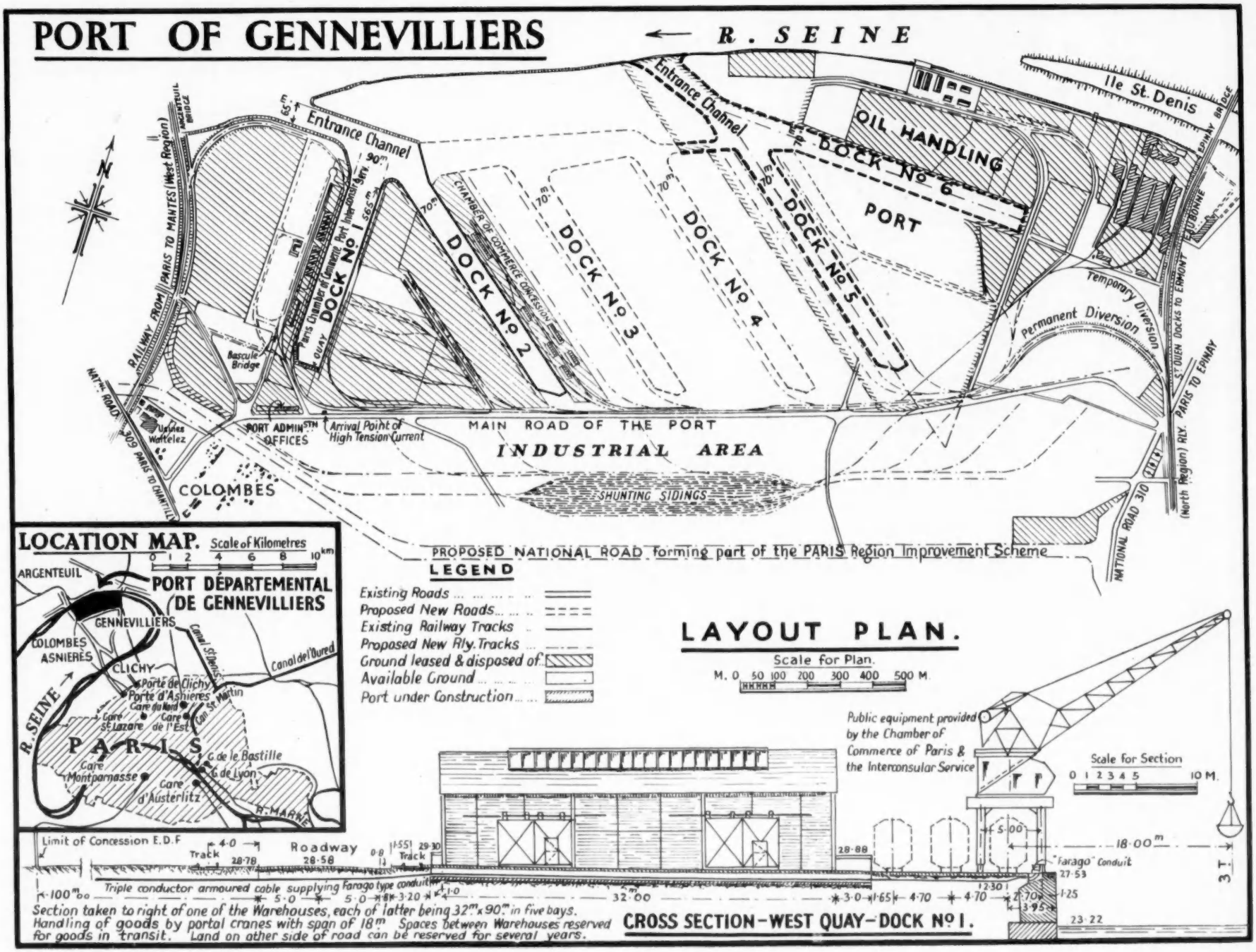
In contrast, the quay on the left bank of Basin No. 1, 500 metres long, has been very well equipped by the Chamber of Commerce of Paris; it is interesting to learn that the Chamber of Commerce of le Havre has contributed towards the cost of this work with the object of favouring traffic coming from overseas through that port, that is to say, transhipped in the port of le Havre from a seagoing vessel to a river craft bound for Paris.

This equipment comprises the following items, namely: three electric portal cranes of three tons lifting capacity, at a radius varying from 8.00 to 18.00 metres, the lifting speed being 90 metres per minute. The cranes can revolve at a speed of two and a half revolutions a minute. There are also two similar cranes with the same characteristics, with a lifting capacity of one and a half tons. There is also a fixed transhipping crane for heavy loads with a lifting capacity of 35 tons, having a cantilever arm 16.50 metres in length and a total length of 46.50 metres; lifting speed varies from 0.20 metre per minute to 0.45 metre per minute accord-



Right bank of Basin No. 1. Tests of the work. Horizontal thrust imposed by water pressure.

PORT OF GENNEVILLIERS



LOCATION MAP.

LEGEND

Existing Roads
Proposed New Roads
Existing Railway Tracks
Proposed New Rly. Tracks
Ground leased & disposed of
Available Ground
Port under Construction

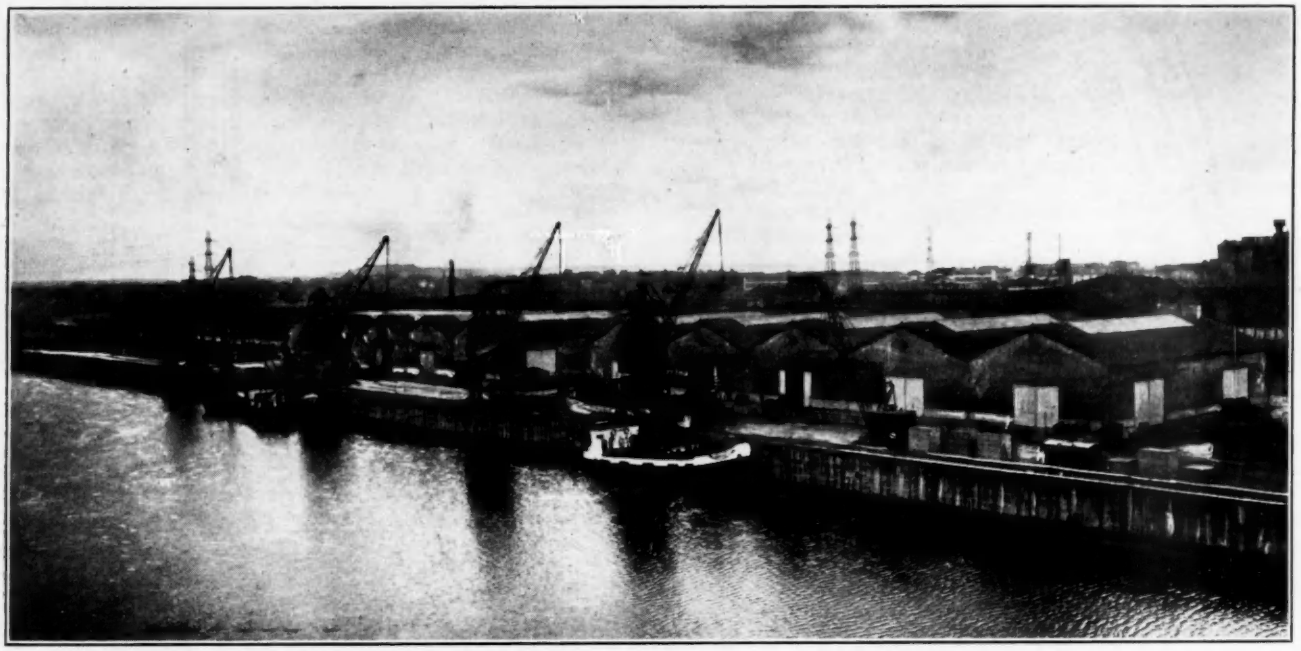
LAYOUT PLAN.

Scale for Plan.
M. 0 50 100 200 300 400 500 M.

Section taken to right of one of the Warehouses, each of latter being 32m. x 90m. in five bays.
Handling of goods by portal cranes with span of 18m. Spaces between Warehouses reserved for goods in transit. Land on other side of road can be reserved for several years.

CROSS SECTION – WEST QUAY – DOCK No 1.

The Port of Genneville, Paris—continued



General View of the 500-metre length of quay equipped by the Chamber of Commerce of Paris. Direct sea traffic between Great Britain and Paris is handled at this quay.

ing to the size of the load. The speed of the bogie horizontally along the boom is one metre per second and this machinery is now in course of erection.

There are two elevated warehouses on the quay each with a storage capacity of 3,000 square metres; another warehouse with area of 2,400 square metres, sited at ground level, is now in course of construction. Three railway sidings paved with stone setts run alongside the quay and there is one siding behind the warehouses. There is also a 50-ton lift bridge for lorries and another lift bridge for railway wagons with a lifting capacity of 120 tons which is at present under construction.

Within the warehouses and on the quay area, both horizontal and vertical transport is carried out entirely by means of fork-lift trucks which give complete satisfaction. The drawing shows a cross section of the quay through the warehouses; the ground on the open quay is covered with concrete. Electric power is distributed at a pressure of 400 volts.

The system of supplying electric power to the cranes deserves special mention. The Chamber of Commerce of Paris is well aware of the well known disadvantages of the usual types of conduits, inadequately protected against entry of water, as well as connections through flexible cables and joint boxes, and has therefore employed, for the first time in France, a system of power transmission patented in Belgium for taking direct current along the 500 metres of quay. The conducting cables are contained within a watertight covering of sheet metal and are normally lying horizontally, being lifted by the passage of the trolley as shown in the cross-section in the drawing. This arrangement, although somewhat expensive, has given satisfaction since it was put into service.

All the above port installations are completely closed and come under the inspection of the Customs officials; goods can be passed through the Customs on the quay or in the warehouse or they can be put into bond in one of the port buildings.

Industrial Installations.

As has already been explained, the Port of Gennevilliers owns a large area of ground adjoining both the navigable waterway and the railway, which can be developed either for the use of industrial development or for bonded warehouses. The following is a review of the present position :—

(1) The ground on the right bank of Basin No. 1 is employed for the reception, storage, sifting and briquetting of coal, and several private concerns have installations there. One has erected a portal type coal transporter with a length of 120 metres which runs along the length of the quay. Another concern has built a very modern handling plant, the layout of which is shown in the photograph of the scale model. Similar projects are now being studied for a portion of the ground on the right bank of Basin No. 2.

(2) The construction of a wheat warehouse is under consideration, and this will include a grain silo with a capacity of 200,000 quintals; it is hoped that this project will shortly be put in hand.

(3) An oil handling port has been established on both banks of Basin No. 6; whilst waiting for this basin to be excavated, the oil pipelines from the depôts will be taken temporarily to the Seine. Three depôts with a total capacity of 33,000 cubic metres are at present in service and have already handled about 15,000 tons of oil per month; a fourth depôt is at present under construction. Two further depôts will be in hand within a few months as well as two installations for the storage of liquid gases.

The oil port has ground available for leasing to importers of oil products. The total capacity of 120,000 cubic metres has been authorised by the Directorate of Refineries ; this will result in Gennevilliers being one of the largest oil ports in France where, in addition to transport by water, oil products will be conveyed through a pipeline from le Havre.

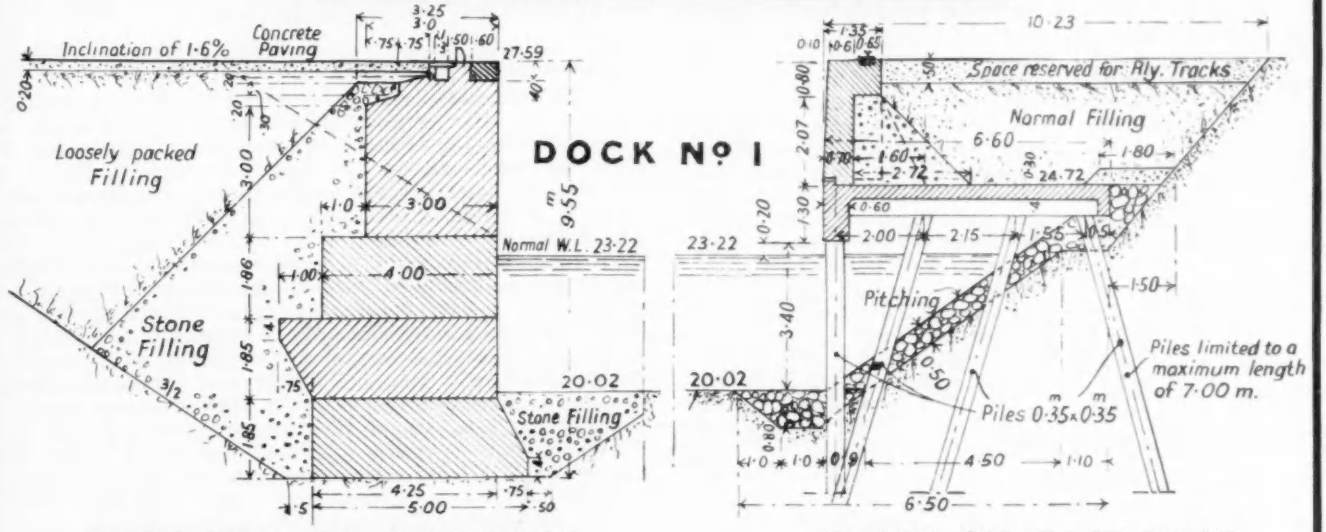
(4) Other industrial and commercial installations are to be erected in the port.

III. Direct Maritime Relations between Great Britain and the Parisian District.

It appears that it was in 1820 that a shipping service was inaugurated between London and Paris via the Thames, the English Channel and the Seine. But it was only after the establishment of a mooring depth of 3.20 metres in the lower Seine at Paris and Rouen that regular steamship services came into vogue before the First World War.

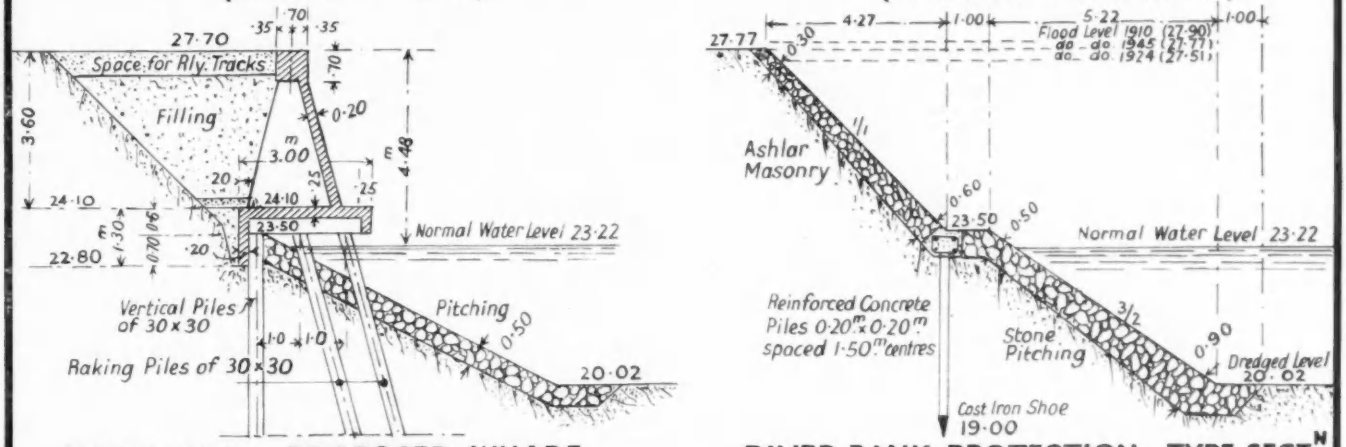
In 1939 there were two shipping lines established, one under the French flag by the Seine Shipping Company, the other under the Dutch flag by the Muller concern; both lines operated a regular service between London and Paris. Their headquarters were located in the warehouses of the Paris-Austerlitz Warehouse Company, where they had available warehouses under the control of the Customs. Since the Liberation the above companies have played their full part in the same manner as before the war.

PORT OF GENNEVILLIERS



QUAY WALL ON WEST BANK.
(Finished in 1939)

WHARF ON EAST BANK.
(In course of construction)



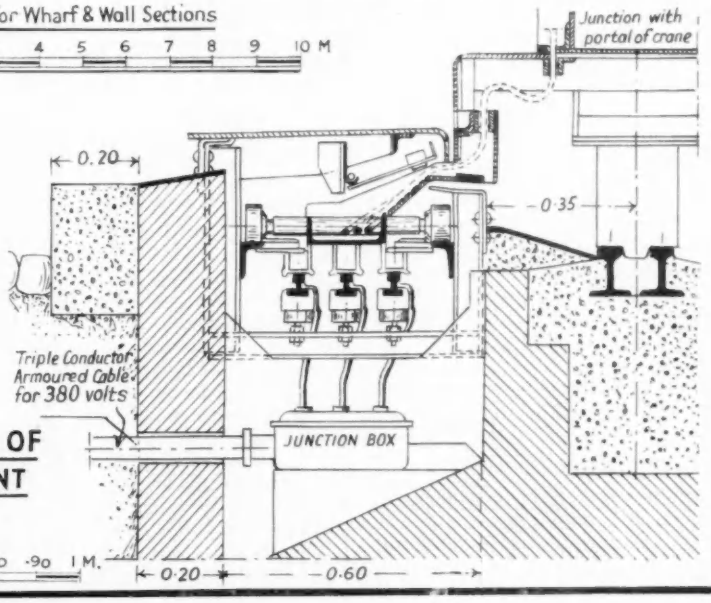
DOCK Nº 2 – PROPOSED WHARF.

RIVER BANK PROTECTION – TYPE SECT.N

Scale for Wharf & Wall Sections

M. 1 ·5 0 1 2 3 4 5 6 7 8 9 10 M

DETAILS OF STRUCTURAL WORKS.



CROSS SECTION OF "FARAGO" PATENT METHOD OF TAKING ELECTRIC CURRENT TO CRANES

Scale for "Farago" Patent

M. 100 50 0 ·10 ·20 ·30 ·40 ·50 ·60 ·70 ·80 ·90 1 M.

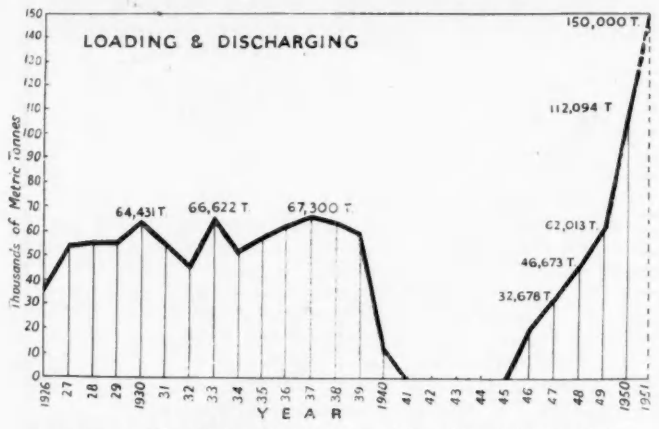
The Port of Gennevilliers, Paris—continued

The Muller Company established itself in the Port of Gennevilliers since it was open to traffic on July 10th, 1950. The Navalsa Company operates a regular shipping line between the Scandinavian countries and Gennevilliers. The Maes concern is about to inaugurate a regular line between Hull and Gennevilliers. Finally, various ships of other companies, some of them flying the British flag, run between England and Gennevilliers. A glance at the graph of maritime traffic of the Port of Paris, which includes cargoes shipped through the port of Austerlitz and of Gennevilliers, demonstrates the popularity of this form of transport; from 60,000 tons before the last war, the tonnage increased to 110,000 tons in 1950 and during 1951 it looks like attaining 150,000 tons, as indicated by the following recent figures :—

January, 1951	8,261 tonnes
February	10,548 ,,
March	14,911 ,,
April	13,380 ,,
May	15,605 ,,

In the above figures, the traffic with Great Britain represents about 70% of the total. Although these tonnages cannot be considered as negligible, they are important in view of the high value which they represent.

At first the development of direct coastal transport between Great Britain and the Parisian district was somewhat doubtful; in



Maritime traffic of the Port of Genevilliers from 1926 to 1950.

the meantime it has become a reality in view of the progress of road transport, by the use of which it appears that the small cargo is in favour because it can be transported from " door to door." British shipowners will appreciate the advantages of direct maritime transport with Paris. In order to emphasise this point, we give the following details of the nature of goods transported during the year 1950 :—

Maritime Traffic of the Port of Paris with Great Britain

	Exports	Imports (all in metric tons)	Total
Combustible oils	21	—	21
Materials of construction such as cement and ceramics	884	1,056	1,940
Organic manures	1,106	—	1,106
Timber products	16,578	773	17,351
Manufactured engineering products, such as machines and engines ...	1,674	9,060	10,734
Primary materials from the metallurgical industry	488	575	1,063
Industrial products such as soaps and greases	9,458	13,075	22,533
Agricultural products such as cereals	2,647	555	3,202
Spices, sugar, wines and liqueurs ...	19,999	2,178	22,177
Hydrocarbons such as oils and greases	1	34	35
Totals	52,856	27,306	80,162

It will be noted that coal does not figure in the above table. Meanwhile, if Great Britain one day resumes her exports to France of good quality anthracite it would appear that the direct transport of cargoes of 400 to 500 tons to Gennevilliers, eliminating numerous transhipments, is a subject worthy of close study. The advantage would appear to be two-fold in view of the fact that many British mines make use of wharves at which only small vessels can be loaded.

Conditions of Navigation between le Havre and Paris.

(a) **By the maritime Seine :** The estuary of this river has a length of 112 kilometres to the first bridge at Rouen and the channel is liable to variation. The velocity of the current can attain five knots between Quilleboeuf and Berville. There are regulations for maritime navigation and pilotage is compulsory as far as Rouen. Ships have to stop at the latter place for Customs examination.

(b) **By the River Seine :** The length from Rouen to Gennevilliers is 208 kilometres, and from Rouen to Austerlitz it is 243 kilometres. The mooring depth of the channel is about 3.20 metres, and for some years ahead the clearance between normal water level and the underside of some bridges will be limited to 6.00 metres. Between Rouen and Gennevilliers there are seven locks at Amfreville, Notre-Dame de la Garenne, Port-Villez, Mericourt, Mureaux, Carrieres and Bougival. Each of these has at least two lock-chambers, one of 53 metres with doors of eight metres, the other from 150 to 200 metres with gates of twelve metres. The National Geographical Institute has published a very complete chart of the Seine from Rouen to Paris at a scale of 1 in 10,000, on which is marked all locks, bridges and the navigable channel; the locks are not open at night, and seagoing vessels have priority of passage through the locks.

Captains of vessels must have a special "certificate of capacity" for river navigation; in practice they are helped by a French sailor from Rouen or from Paris who has the necessary certificates.

Taxes and Dues.

A seagoing vessel proceeding in passage from Rouen to Paris must pay the following: pilotage dues if its tonnage is greater than 50 tons; toll tax; and quay dues. At Gennevilliers, only cargoes consigned to the Department of the Seine pay a small tax in accordance with the tonnage handled; the Chamber of Commerce of Paris is responsible for the charges of shunting and storage. Full details cannot be given here of the various charges, which alter according to the season, but we are ready to answer any questions which may be submitted to us on this subject.

Characteristics of Vessels plying between Great Britain and France.

There are at present about 50 small cargo ships running between Great Britain and Paris, Austerlitz and Gennevilliers. Those of the Seine Shipping Company were built in French shipyards and have the following dimensions: length 51.6 metres; beam 7.20 metres; gross tonnage 388 and nett tonnage 185, with a deadweight carrying capacity of 517 tons at a maximum draught of three metres. Maximum height above water in the unloaded condition is 4.50 metres, and each vessel is propelled by an oil engine of 420 horsepower, giving a speed at sea of 10 knots.

Many of these vessels, and notably those of the Muller Company, are classed in the Dutch category known as the Gronin-Gers. The high quality of these vessels and of their crews is well known in all ports of the English Channel and of the North Sea; they go up the Rhine as far as Cologne, through the Brussels Canal, and can ascend the Thames above the bridges. The following are the main dimensions of one of these ships which voyages regularly to Paris : length 46.00 metres; beam 7.47 metres; deadweight carrying capacity 490 tons when drawing 2.90 metres of water. The height above the water in the unloaded condition, with 150 tons of ballast, is 4.20 metres, and the vessel is propelled by an oil engine of 350 horse-power giving her a normal sea speed of 10 knots.

We are not looking too far into the future, but only to the time when the mooring depth in the Seine will be increased to 5.00 metres, and we suggest that the future vessel for this service should have the following characteristics: maximum loaded draught of 2.90 metres and maximum height above water level of 5.00 metres. In a few years the heightening of the bridges will be

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Co-ordination in Cargo Handling

Suggested Formation of International Body

It will be recalled that, in the March 1951 issue of this Journal, a letter from Mr. A. C. Hardy was published in which he suggested the formation of an International Cargo Handling Co-ordination Committee to investigate methods of ensuring a quicker turn-round of ships in port. Since that date, several preliminary meetings have been held by those interested in the scheme, and Articles of Association of the proposed new Organisation have been prepared and discussed, among those interested.

The Articles of Association state that the International Cargo Handling Co-ordination Committee has been formed with the object of studying, by the interchange and correlation of information, means whereby ships' turnaround time in port can be reduced to a minimum by using the most modern methods of loading and discharging from ship and/or shore, thus assisting in the use of ships to better advantage, and enabling sea-speed (which is continually increasing) and port speed to be co-ordinated.

The new organisation is a private concern with membership from those able to help towards these ends, including shipbuilders, manufacturers of cargo-handling gear for use on board ship and ashore, Port Authorities, Chambers of Commerce, Stevedores and Dockers, Packers, Manufacturers of Packing Equipment, Importers and Exporters, and Users of Bulk Mineral Cargoes.

The aim of the Association is the exchange of information on cargo-handling technique by means of the reading and discussion of papers, and the exchange of visits. In time it is hoped that the Committee will be able to analyse any particular problem and to make recommendations for its solution.

Article IV states that it is proposed to divide the researches into eight sections, within the framework of which, studies will be carried out as follows :

1. **Shipbuilding**—problems concerning the construction and arrangement of ships' cargo-handling gear, side doors, derricks, cranes, winches, and all technical improvement on or within the ship, designed to speed up dispatch.
2. **Shore Cargo Handling**—will deal with all methods of packing and handling in big works, factories or stores ashore, destined to make discharge and loading easy and as far as possible—internationally standardised.
3. **Labour**—will investigate all problems concerning manpower in so far as it concerns loading and discharge. It also will disseminate information about training, welfare, medical centres, canteens, safety from pilferage, averages and insurance.
4. **Authorities**—concerns official bodies — Ministries, Customs, Public Works, Light and Buoyage Departments, Port Authorities, Chambers of Commerce etc.
5. **Non-Sea Transport**—will deal with railways, roads, canals, air transport — complementary transport systems — considered in many cases, and at many places, to be responsible for delays in loading or discharge.
6. **Model Tests**—viewing with interest the importance of experimental tanks to improve hull lines or propellers, the Committee proposes that " laboratories " for cargo handling should be developed, and the results of tests on scale models widely published.
7. **Colonial and Open Roadstead Cargo Handling**—loading and discharge of ships lying offshore, with heavy tides, swell and surf, in tropical rain, or hot sun, with native labour, will form the principal matters for study in this section, as a contrast to handling in a well mechanised port, bearing in mind that in both extremes the same ship may be involved. Co-ordination of these different conditions will be dealt with, as well as the general possibilities of speeding up handling at primitive harbours.
8. **War Transportation**—will investigate the important problem of handling war materials, and will study such matters as how the cargo handling gear of a normal cargo ship can be put to best use in times of war. How most safely to handle and carry dangerous materials or munitions, and what kind of packing should be adopted for troops' equipment.

An Addenda to the Articles of Association states that, as the reason for the existence of the Association is purely the study of ways and means whereby the period of turn-round of ships in port can be reduced to that consistent with their speed at sea, the Association will be liquidated when the problems involved have been solved to the satisfaction of all concerned.

The Association is in no way to be considered as an association of dock and harbour authorities, or stevedores or shipbuilders and shipowners, or makers of cargo handling gear, with members all belonging to the same professional family whose aim it is to co-ordinate information within that family.

On the contrary, the International Cargo Handling Co-ordination Committee is a union of various branches of activity and is representative of several industries, for example, packing material makers, packers, cargo gear handling manufacturers, shipbuilders, shipowners, stevedores, importers and exporters. Its aim is in no way to co-ordinate within one corporation or to any individual extent, but through the various different corporations according to the profession of the members, the co-ordination being first on a national basis and then between several countries.

The Port of Gennevilliers, Paris

(concluded from previous page)

completed, when the clearance above water level will be 9.00 metres and this will probably be available for nine or ten months in the year. Maximum speed in the Seine will be from seven to eight knots. Vessels with a beam of 11 metres can be accommodated in the large locks, but in the meantime it appears to be desirable to limit the maximum dimensions to a length of 51.50 metres and a beam of 7.50 metres, which will enable a vessel of this size to negotiate the smaller locks and thus to save time.

The British Merchant Navy has motor coasters with a deadweight carrying capacity of 400 tons and drawing 10-ft. of water which can come to Paris. It is suggested that shipbuilders and shipowners should devote thought to this subject. For example, we can visualise vessels of greater tonnage in the same class as those which can ascend the Rhine as far as Cologne.

There is no doubt that the Department of the Seine and the Chamber of Commerce of Paris are together creating a modern port system for the Paris district. It is hoped that this article will stimulate interest in Great Britain because of the new opportunities now opening up for increased trade between our two countries.

Correspondence

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

Education Scheme for Port Workers

I am pleased to see that you are including in your Journal the articles on Port Working in the United Kingdom in connection with the new Education Scheme for Port Workers. They are most welcome and will, I am sure, give considerable help to intending students.

Unfortunately, in the September issue the section on page 166 dealing with inland waterways contains certain comments which are incorrect or misleading. It is stated that inland waterways are slow; that goods are at risk for a longer period than in the case of other methods of transport; and that only low-value, bulk commodities are usually carried.

Water transport is by no means so slow as is commonly assumed, and it has the advantage over considerable distances of being steady and continuous, because it is not subject to delays through marshalling or traffic hold-ups.

As regards the period for which goods are " at risk," relatively, very low claims are made for loss or damage by inland waterway transport, and it is significant that fragile goods such as porcelain have proved eminently suitable for carriage by waterway. Valuable and scarce cloth has been sent from inland areas to ports in recent years without any claims arising.

Though bulk, low-value, commodities form a large proportion of water traffic, it should not be overlooked that considerable quantities of flour, foodstuffs, wool, cased goods, provisions,

Correspondence—continued

metals, etc. are also regularly dealt with. Some reference should be made to the important and expanding bulk petroleum traffic carried on the waterways. This is proving not only an economical method of transport, but also a safe and speedy one.

The reference to maximum loads of 30 tons by horse-drawn barge and 50 tons by power craft and butty boats applies only to the narrow canals. To avoid presenting a distorted picture the capacity of the wide waterways must be taken into account. In the North Eastern Division, where nearly all the waterways are wide, the majority of the vessels can carry from 80 to 140 tons each, and some craft carry up to 250 tons. The Weaver Navigation and the River Severn (as far as Worcester) can accommodate vessels with carrying capacity up to 400 tons each.

It is not usual for charges to be made by way of locking fees on each occasion a craft uses a lock because tolls are inclusive of the use of locks, so far as merchandise craft are concerned.

Yours faithfully,
L. A. GOSS,
Information Officer.

Docks and Inland Waterways Executive,
22, Dorset Square, N.W.1.
28th September, 1951.

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

Education Scheme for Port Workers

I have read the letter from the Information Officer of the Docks and Inland Waterways Executive in which he takes exception to certain comments regarding inland waterways made in the September article of the " Port Working " Series.

One of the difficulties in writing a series of articles of this character is to keep matters in a general vein, and not to particularise too closely. I have every admiration for the way the Docks and Inland Waterways Executive are tackling their problems and I know something of the difficulties with which they are beset, and it was not intended in any way to minimise or disparage their efforts.

I have tried throughout this series of articles to urge that *all* relevant circumstances of a transport problem be considered before reaching a conclusion on any particular issue.

The generalisation made as to speed (admittedly it was sweeping) is borne out by the facts. Most of the canals of the U.K. (both broad and narrow gauge) are governed by codes of Byelaws one of which usually restricts the speed of craft in transit to anything from 3 to 6 miles per hour. It is obvious that any self-propelled craft proceeding at a speed greatly in excess of this (unless in stretches where banks have been sheet piled or otherwise protected) must imperil the banks by wash damage.

The comment regarding maximum loads must of course keep in mind existing canal drafts. It is no comparison to take the tonnages of craft working on river estuaries (such as the Severn and the Weaver). Transhipment would be necessary for any goods passing to the Midlands via either estuary. The Executive unfortunately cannot escape the fact that several of their predecessors did not think the Midlands and Birmingham (the centre of the " Cross scheme " advocated by the Royal Commission) offered a sufficiently paying proposition to warrant the construction of a broad gauge canal system to serve it.

The statement that charges for " locking fees " are made on each occasion a craft uses a canal authority's locks is supported by the fact that many of the canal owners (Conservancy bodies, River Boards, etc.) other than the Executive, do in fact make some sort of separate charge for the use of the locks. Thus the Thames Conservancy make a separate charge (which can be paid to the various lock-keepers) for a tug towing craft (whether these are empty or loaded). This is the usual system where tolls and locking charges are paid separately.

Before acquisition by the Executive, a number of the railway owned canals (and the Leeds and Liverpool Canal Co.) made a special charge for " lock dues " covering the passing of the locks. This was in addition to the canal dues on the craft.

The canals are essentially bulk carriers, and this must rule them out of carrying the many commodities that only move in small parcels. The former Grand Union Canal Company carried uncased motor cars on its waterway, and the carriage of such easily-damaged merchandise as porcelain pottery also is eminently suited to canal transport, since both are reasonably constant in flow, but the point is that few places can take, say, a barge load of cloth or foodstuffs. Such freight as mentioned by your correspondent must, in the nature of things, be very specialised and local. Bulk petroleum traffic is in rather a different category. This trade is expanding everywhere, and for some years past, the aim of the large oil companies has been to build small storage and fuelling depôts, having water frontage, so that tank barges can serve them from the main storage depôts at the ports. These smaller depôts serve as distributing points for their areas using road transport tankers.

Yours sincerely,
Your Special Correspondent.

Ilford, Essex.
21st October, 1951.

Book Review

Propagation of Tides and Similar Waves. J. C. Schoenfeld. Published by the Ministry of Works in the " Waterstaat." State Press, the Hague, 1951. Large quarto, 232 pp., 118 illustrations and 12 folding plates.

This is a very interesting but rather technical treatise, in English, on tidal waves and currents, based on work done by the author at the Hydraulic Laboratory at Delft. It is particularly interesting at the present moment since it incorporates the work of Lorentz which was of fundamental importance in the study of the Zuider Zee and was much referred to in connection with the flood problems of the Great Ouse before Select Committees of both Houses of Parliament prior to the passing of the 1949 Act. The initial studies by de Vries Broekman in 1916 showed that the differential equations of the tidal motion could be developed practically. Lorentz's masterly expansion of this in 1926 was regarded by Dutch engineers as of paramount importance and the fundamental principles form an essential part of all hydrodynamic studies in all Dutch universities, laboratories and research stations. Dronkers, Mazure and others have since supplemented the work of Lorentz.

The book opens with a general introduction extending to 14 pages, followed by two sections dealing with the mathematical and physical approach, and then the empirical approach. Three appendices follow.

Students will be particularly interested in the analysis of the resistance. It is well known that the usual Dutch practice assumes the truth of de Chezy's rule, whereas English and American methods usually adopt Manning's rule. The artifices employed by the author to deal with the acceleration effects are particularly noteworthy.

Two summaries, in Dutch and French respectively, are provided. A bibliography of sixty-seven items concludes the work.

It is to be feared that the ordinary engineer will find this treatment of the subject somewhat indigestible. Even the use of differential equations in tidal theory (such as occurs in Doodson's " Admiralty Manual of Tides ") is generally unfamiliar to him. Lamoen's article on " Tides and Current Velocities in a Sea-level Canal " "Engineering" (July 29, 1949) will give a good idea of the general technique.

An unique feature of Schoenfeld's work is the introduction of " characteristic " wave components. It is well known that waves of " oscillation " as distinguished from waves of " translation " can be represented by two waves of translation moving in opposite directions and serves well for the various reflection phenomena which occur against vertical walls, etc. The author has generalised this practice following a technique introduced by the celebrated mathematician Cauchy (1789-1857) and the results although difficult to follow, appear to be quite important.

An interesting analysis of hydraulic " jumps " and bores appears on p. 188-192.

H. C.

Port Oganisation and Finance

Fourth Instalment of a Series of Three Articles contributed for the New Education Scheme for Port Workers

(By a Special Correspondent)

In this, the last article of this series, it is proposed to deal with the following topics.

1. Constitution of Port Authority.
2. Organisation and functions of staff.
3. Provisions of the British Transport Act 1947 in relation to port undertakings.
4. Chief sources of revenue.
5. Main trends of expenditure, and collection of revenue.

1. Constitution of Port Authority.

Brief historical review of port controlling bodies in the U.K. prior to the Transport Act, 1947. The present systems of control in the U.K. Constitution of certain of the public trust port authorities. Nominated and elected members, and representation of Governmental and Public bodies. Municipal and private company ownerships.

Prior to the coming into force of the British Transport Act 1947, there were five systems of port control in operation in the U.K. They were:

(a) The Public Trust (e.g. the Port of London Authority, Mersey Docks and Harbour Board, and Clyde Navigagation Trustees).

(b) The Railway (e.g. the Southern Railway controlled Southampton, the L.M.S. Railway, Grangemouth).

(c) Municipal (e.g. committee of the Bristol Corporation controlled Bristol (including Avonmouth and Portishead Docks) and Preston Corporation the Port of Preston).

(d) Company (e.g. Manchester Ship Canal Company controlled the Manchester and Salford Docks).

(e) Private (e.g. Granton Harbour Ltd. controlled the Port of Granton).

It should be noted that in the major ports of the U.K. practically none of the Public Trusts are completely masters in the ports for which they are, in general, responsible. Often one finds two so-called " authorities " in the same port area. The only case of a large port having control of all estate, commercial and operating activities within itself, except shipbuilding and repairing, is Manchester, where the port authority is a Public Company. This lack of complete control has made for confusion and difficulty in framing legislation in the past when dealing with decasualisation and matters affecting labour, and has been one of the stumbling blocks to any system of port grouping etc. put forward.

The fact that few ports of the U.K. were controlled and administered in the same way, even by railway managements, or had comparable responsibilities within their respective areas, made general legislation, to cover all, impossible.

The first " trust " Port Authorities, the Mersey Docks and Harbour Board, and the Clyde Navigation Trustees appeared in 1858. The first named owed its formation primarily to the failure of the Corporation, the previous owners of the enclosed docks on the Mersey Estuary, being unable for various reasons (among which was alleged misuse of dues, these being diverted and used for town purposes rather than river and dock improvements) to keep their undertaking up to date, and so cater for the increasing ship dimensions and traffic using the port. The Board was vested with ownership of all existing enclosed docks in the Estuary (including Birkenhead) and had the river and estuary conservancy duties to carry out, including control of the pilotage. Monopolistic powers as regards building further dock accommodation on the Mersey were conferred upon it.

The object was to combine the principal wharfinging and dock owning interests in the river or estuary and so eliminate wasteful competition. Past experience had shown that the dockowners, by charging rates attractive to shipowners and merchants but uneconomic to themselves, had starved their undertakings of the capital necessary for improvements. The Clyde Navigation Trust's Act was a consolidation and extension of powers conferred by previous Acts. It amended the constitution of an existing Board, and greatly added to its responsibilities.

Bristol was the victim of competing dock companies until the City Corporation acquired the then existing docks, and proceeded to modernise them, the town rates being employed to cover any financial losses arising out of the operating of the docks etc. The Bristolians regard their port as a municipal investment bringing trade and employment to the city and therefore worth an annual contribution, if necessary, from the rates.

Southampton, although a very old port, began its dock era in 1836 when the Southampton Dock Company was incorporated by Act of Parliament. The first dock (the " Outer Dock ") was opened in 1842 and another (The " Inner Dock ") was opened just in time for handling transports for British troops to the Crimea. In 1892 the existing docks (there were by then three) and the Itchen Quays passed to the control of the L. and S.W. Railway Company.

Most of the earlier railway owned docks started as the property of a Joint Stock Company being bought up by the various companies and at the passing of the Railways' Act of 1921 (amalgamating the railways into four groups) a large dock acreage in the U.K. was railway owned and controlled. All such docks etc. had been developed mainly as feeders to the railway system owning them until putting into operation of the British Transport Act, 1947, transferred all railway owned docks to a new body, created by the Act.

The Manchester Docks and Ship Canal were constructed by a public company known as the Manchester Ship Canal Company. It obtained Parliamentary powers by the Manchester Ship Canal Act 1885, and was to be a profit making concern. Great difficulties were encountered during construction of the works, the City Corporation finally coming to the rescue financially and staving off bankruptcy before completion. It seems certain that nowadays no privately promoted and owned undertaking could finance a work of similar magnitude.

The Port of Granton, near Edinburgh was built in 1837 by the Duke of Buccleuch as a private individual. It came under the control of a limited company in 1932 when the Granton Harbour Ltd. with the present Duke as Chairman, and members of the family as co-directors, was formed.

All major port authorities have been constituted by separate Acts of Parliament (often the Act authorising the construction of the works setting out in detail the constitution, jurisdiction, functions, powers and duties with financial arrangements including maximum borrowing and charging powers. These Acts represent a very considerable amount of legislation.

The Trust port has evolved during the last 100 years, and the present bias is towards extending this form of administration. The Board consists partly of members elected by and representing the payers of dues and charges on shipping and goods using the port, and partly of members appointed by Government, Local authorities and sometimes Trade Union interests, all members usually giving their services, although the Chairman and Deputy may be salaried.

The Trust port usually issues capital in the form of Port Stock, bearing fixed rates of interest and there is no distribution of profits, any profits made usually having to be used towards reducing

Port Organisation and Finance —continued

the port dues and charges. Others use short-term loans, Funded Debt issues etc. for their finance.

The Stockholders generally have no voice whatever in the management, with the exception of the River Wear Commission. The broad aim is to obtain the services on the Authority's Board and the various Committees thereof men who represent the ports' main trading interests (both shipping and mercantile) using the port.

The numbers of, and qualifications for members composing a port authority are usually presented in detail in the private Act of Parliament whence the authority derives its powers. The British policy has been for a certain small number of nominated members to serve for a fixed term of years. Nominations may be made by a State Department (Ministry of Defence, Board of Admiralty etc.) statutory bodies whose business is intimately connected with the port (local County or Borough Councils, Conservancy or River Boards etc.). The greater number of members however, is usually elected by periodic ballot of the shipowners, merchants etc. who make use of the port in their business, the principle being that the payers of dues and charges have the maximum say in the management of the port.

London has appointed members nominated by the Admiralty, Ministry of Transport, Trinity House, City Corporation and London County Council, with 18 members elected by payers of dues on ships and goods. Newcastle has members nominated by the Ministry of Transport, with six representatives of Local Corporations as appointed members, with 17 elected members (5 each by shipowners, coalowners and traders and two by payers of dues). Belfast Harbour Commission has for Chairman the Minister of Commerce, with the Lord Mayor of Belfast and 19 Commissioners (including the Chairman of Harland and Wolff Ltd.) as members. There is no set pattern for a port authority.

The acquisition of the four British Railway groups that had existed in the U.K. prior to the setting up of the British Transport Commission by the Transport Act of 1947, had the effect of removing some of their ancillary activities from the control of the railways.

Their canal and trade harbour undertakings (the only exceptions made were the purely railway steamer terminals such as Folkestone, etc.) were transferred to the appropriate Executive of the Commission (the Docks and Inland Waterways) the railways themselves being transferred to the Railway Executive, their hotels to the Hotels Executive and their road transport undertakings to the Roads Executive.

From the " appointed day " (1st January 1948) under the terms of the Transport Act of 1947 all railway ownership of U.K. trade harbours came to an end, and their undertakings passed into the hands of the Dock and Inland Waterways Executive to operate and control as they deem fit in the public interest.

For the first time in history a number of the ports of the U.K. came under public ownership, their control being in the hands of a public corporation known as the British Transport Commission, set up and working under a Public Act of Parliament.

Municipal ownership of port facilities is usually traceable to local initiative in bygone days having come to the rescue of the original undertakers with financial assistance from local funds when it appeared that bankruptcy with eventual decline and decay of the port facilities threatened to affect trade and employment in the town. As stated above, the Manchester Corporation eventually came to the financial aid of the Ship Canal Undertaking mainly because it was regarded as a good " long term " investment for the town.

Of U.K. company controlled ports, the vicissitudes of the Manchester Ship Canal Company during the construction of the canal, and the disappointments of its earlier years of trading (it made no profits at all for some years after it was first opened) makes it extremely unlikely that adequate finance could nowadays be forthcoming for a port undertaking of any magnitude to handle general cargoes, even assuming the British Transport Commission could be induced to give their permission for its construction, which would now be necessary.

The day of both company and private construction of general port facilities has passed, although no doubt for many years yet, riverside jetties and wharves, small company and privately-owned docks for special purposes or trades (viz. fitting out basins etc. for ship building) will, owing to their smaller capital requirements, continue to be constructed for dealing with special commodities, raw materials for a riverside factory etc. This particularly applies to thōse estuaries and rivers where it is necessary for a public conservancy or port authority to undertake that most expensive of capital projects, viz. the dredging and maintaining a wide and deep navigable approach channel from the sea.

The great advantage of company or privately-owned ports is their freedom from Parliamentary interference and of boards biased towards road, water or rail transport. They are out primarily to make a profit, and therefore cannot favour one branch of inland transport at the expense of another. A criticism against former railway owned ports was that the port was regarded as ancillary to the railway and as such, traffic from or to the port by any other system of transport was not encouraged.

Of all systems of U.K. control, the " Trust Port " it is generally agreed, can by its representative board, secure the best local mercantile and shipping brains for its management and operation, and although it does sometimes happen that a forceful personality becomes dominant, there is less chance of this than in a company or privately-owned port. The Trust Port is fairly free from Parliamentary interference, although events since 1939 have shown that this is a fast disappearing advantage.

2. Organisation and Functions of Staff.

The Board and Committees. The Chief Executive. The functions of the Administrative and Executive Departments. The internal organisation, viz.: Commercial, legal, and accounting departments. Traffic, operating, engineering, river conservancy and police.

As with the constitution of port governing bodies themselves, the functions of the Committees set up by them differ greatly in scope, being conditioned by whatever powers and duties are conferred upon the Board or Commission by the particular Act (or Acts) of Parliament under which it operates, as well as the general character and layout of the port.

The Board itself would be the body who would make major decisions of general organisation, settle policy, sanction schemes put forward by its executives (or chief executive if there is one) for consideration, and would negotiate, if necessary, with the Minister of Transport (who usually has, under the private Act, some sort of control over the port authority) and the Government Departments in connection with the port.

The Board would appoint small numbers of its own members to act as committees to deal with one or more of the ports many-sided activities. For any specialised activity arising out of the work of a committee, a sub-committee comprising two or three members well versed in the matter might be appointed to draw up a report for the guidance of the committee.

Each sub-committee reports to its convening Committee and all committees report to the Board by minute. These minutes are ratified (or otherwise) by the main Board for all the members are severally and jointly responsible for decisions taken or policies laid down.

Each major activity or responsibility might have a specially appointed committee of members who would report regularly to the Board. The Chairman and members of each committee would be appointed by the Board itself.

Thus there might be a Dock and Warehouse Committee for the traffic and commercial side of the undertaking, a River or Conservancy Committee for the waterway, a Law and Parliamentary Committee to deal with Parliamentary Bills and various legal questions, a Stores or Purchasing Committee buying stores and materials, etc., for the whole undertaking, a Staff or Establishment Committee to appoint and control staff, a Maintenance or Works Committee responsible for upkeep and repair of all buildings, equipment etc. Policy and general matters not dealt with by any special committee might, in a large and complex organisation, be dealt with by a General Purposes Committee appointed to make recommendations to the Board on matters arising out of day to day policy and administration, port business etc.

Port Organisation and Finance—continued

Each Committee has minutes drawn up by the Secretary of the undertaking for submission to the full Board for confirmation or otherwise. The Chairman of each committee would be a person well versed in the particular branch of port work it dealt with. Thus a retired naval officer or merchant sea captain of some distinction might be Chairman of the River or Pilotage Committee (assuming the port pilotage was under the control of the Authority) a prominent merchant or shipowner Chairman of the Dock and Warehouse Committee etc.

The private Act that creates it, lays down the scope and duties of the Port Authority much in the manner that a limited company's Memorandum and Articles of Association set out the objects of a company, method of share allocation, amount of nominal capital, procedure etc. to be adopted to carry out the purposes for which it was founded etc. Indeed the private act takes the place of the Company Memorandum and Articles of Association. Often certain public rights and obligations are involved and for these it may be necessary to grant special powers and dispensations from certain restraints usually placed upon a private company.

The Secretary is the officer appointed under the Act to advise on procedure, functional powers etc. given, and see that " standing orders " are adhered to. These consist of rules of procedure for itself drawn up by the Board, approved (usually on first formation) and subsequently added to as experience dictates. He sees that the policies laid down by the Board are disseminated and carried out by the various departmental heads, and issues over his signature, after due authorisation by the Board, all legal documents, licences and permissions etc. as required by Statute or authorised by the private Act, and acts on all the hundred and one other occasions where the Board, acting under its powers, has to issue documents of authority etc.

The Secretary also sees that any statutory duties laid upon the undertaking in respect of certain public acts etc. are carried out, such as sending copies of the Annual Report and Accounts to the various Government Departments legally entitled to receive these under the Act. His position is in all respects similar to that of the Secretary of a Limited Company in that he acts for the collective body, as he is authorised by them.

The Secretary may be regarded as the senior official on the administrative side. For some of the larger ports there is a Chief Executive official who is responsible for seeing that the policy of the Board, as decided from time to time, is carried out by the subordinate departmental officers. He initiates reports to the Board on schemes for the betterment of the undertaking, keeps an eye on trade fluctuations and movements, and would be responsible for budgetary control. His qualifications may turn upon the particular bias of the undertaking as well as the type of man available. Thus a large port having public duties as well as being a commercial concern might have both a General Manager and a Secretary, the former to co-ordinate all departmental activities the latter responsible for all Parliamentary, legal and administrative matters. A smaller port might combine these offices in one individual with the title " Secretary and General Manager."

The number and titles of other port officials depends on the magnitude of the undertaking and the powers conferred by the Private Act. A senior Executive would be repsonsible (under the Chief Executive) for the carrying out of the orders of a particular Committee (under the Board) for Docks and Warehouses work, a Commercial Manager to obtain new and retain existing traffics. The Chief Engineer would act as the Maintenance or Works Committee Executive, the Stores Officer as the Stores or Purchasing Committee's Executive, whilst the Solicitor would deal with the Law and Parliamentary Committee and advise other departments on any general legal matters.

The professional departments have staffs of experts to deal with each particular departmental aspect, and each sub-department would have a staff of skilled technicians and workmen for the carrying out of its particular function.

The Harbour Master is usually the senior marine officer of the Board. He is responsible for the allocation of berths to shipping, marking and removal of wrecks in the port, surveying and hydrography of the river and docks, the dissemination of navigation notices to users of the waterway and harbour, lighting of piers, jetties etc.; he also has general control of ships using the harbour and anchorages, particularly those used by the Explosives and Petroleum carrying vessels.

The Dock and Warehouse Executive would be responsible for dealing with the goods handling side of the undertaking for the receiving, weighing, sampling, stowing and delivering of goods warehoused with the port, with control of whatever discharging and quay porterage work is done by the authority itself. Some ports divide this department into Quay and Warehouse work under a Cargo Superintendent with stevedoring on ship under a Marine Superintendent.

All the U.K. ports internal organisation (except those controlled by the Dock and Inland Waterways Executive) is departmental in character, i.e. one officer (the departmental head) deals with his particular responsibility throughout the whole undertaking.

Most U.K. ports are compact, which facilitates this type of control. The ports controlled by the Docks Executive are scattered over the country (South Wales, Kings Lynn, Southampton, etc.) and the organisation is by areas (divisions).

3. Provisions of the Transport Act, 1947, in relation to Port Undertakings.

The aim and scope of the Act. The British Transport Commission. The Docks and Inland Waterways Executive and its responsibilities. The Act as it affects U.K. ports and "Trade Harbours." The procedure for promoting the aims of the Act. The preparation of schemes (under Section 66 of the Act).

The British Transport Act, 1947, virtually aimed at the nationalisation of transport, was one of the leading social experiments of the Labour Government of 1945. The Act (which consists of nine parts and 15 schedules) set up a public corporation or authority in Great Britain (known as the British Transport Commission) which is in effect the governing body of the whole of nationalised inland transport. This Commission operates through a number of Executives, the devolution being functional and not geographical (except in the case of the London Transport Executive). The Act sets out to create a publicly owned system of inland transport (except air transport), including port facilities, there being a general duty laid upon the Commission to provide an efficient, adequate, economical and properly integrated system of inland transport and port facilities within Great Britain.

The Minister of Transport has wide powers over the Commission, mainly with the object of fitting it into the general state governmental machinery. He can by general direction delimit the scope of its activities, control capital expenditure, and slacken or expedite the pace of acquisition of road passenger transport or of the organisation of the trade harbours. He also appoints the various consultative committees set up under the Act.

The Commission consists of a chairman and between from four to eight members (it now has four full-time and one part-time member) appointed by the Minister from persons with wide experience in transport, industrial, administrative or commercial matters, or the organisation of labour.

The various businesses carried on by the Commission are virtually one undertaking and the total revenue received must be at least sufficient to meet the total expenses incurred " taking one year with another." Detailed annual accounts in respect of each of the Commission's activities have to be prepared and laid before Parliament.

The Docks and Inland Waterways Executive is the public authority set up under the Act to whom is delegated the duty of operating the Canals and Trade Harbours acquired, and exercise supervision over such port or harbour amalgamations, groupings, etc., as they may suggest are in the public interest. They prepare and submit schemes for the better operation, co-ordination and grouping of port facilities. The Executive consists of a chairman and between four and eight members (it now has (1951) three full-time and two part-time members). The qualifications required of these are similar to those of the Commissioners, and the Executive is treated as the employer of the staff.

To give users of transport an opportunity of making representations, certain consultative committees have been established, each consisting of an independent Chairman and such persons as the Minister decides to represent the interests of agriculture, commerce, industry, shipping, labour and other authorities, together with

Port Organisation and Finance—continued

nominees of the Commission, and not more than two non-representative members.

Part IV (Section 66) of the Act which deals with schemes as to harbours, defines " trade harbours " as those in Great Britain which are or form part of or abut on harbours not normally exclusively used by pleasure steamers, yachts, fishing vessels and vessels not requiring to be registered under the Merchant Shipping Acts, 1894 to 1940. Harbours that form part of a dockyard are excluded (i.e. Sheerness, Portsmouth, etc.). The Minister may direct the Commission (who delegates its executive) to prepare a scheme with respect to a particular harbour or group of harbours. This must be done in consultation with persons carrying on the harbour undertakings, including representatives nominated by the Commission of shippers, traders and workers who may be affected. The Commission (Executive) are empowered to keep the " trade harbours " under " continuous review " to determine whether their powers of acquisition or " scheme making " shall be exercised in respect of any one or all of them. They may provide, or authorise some other body to provide, port facilities in connection with any dock or harbour concerned, and decide what is to be provided, but they cannot reserve to themselves or to any other body exclusive rights of providing port ancillary services in any harbour. Private docks may only be made the subject of a scheme by agreement, or if governed by a private Act of Parliament, by a Statutory Order. Such schemes must be published by the Minister in the form of an Order. The Commission (Executive) may prepare and submit to the Minister (of Transport) a scheme for promoting or facilitating the promotion of the provisions of port facilities in or in connection with the harbour or group of harbours.

The Executive may grant licences for the operation of port facilities in certain cases (to be current for not less than seven years) in order that facilities may be provided in a port subject to a scheme. Such licences may be revoked, limited, made the subject of conditions, or refused, if the Executive consider that by so doing the better operation of the harbour in the national interest can be secured.

Part V of the Act directs the Commission (within two years of the passing of the Act or such longer period as the Minister may allow) to prepare and submit the draft of a scheme, or the drafts of schemes, relating to charges, terms and conditions of carriage, and liability for loss or damage, for all the services and facilities provided by the Commission.

This section is that upon which all terms and conditions of carriage of both goods and passengers carried by the Commission will be founded and it covers port facilities, facilities for traffic on inland waterways, and the warehousing of goods.

The original intention was to have the initial schemes prepared before August, 1949, and submitted to the Transport Tribunal for their consideration. For a variety of reasons this is the most controversial part of the Act, and the initial period has had to be extended by the Minister on two occasions.

The exact system to be employed for the determination of charges and the terms and conditions of carriage is deliberately left to the Commission to decide, but it is laid down that the aim of any charges scheme(s) must be to produce such a revenue as will cover the cost of the Commission's operations " taking one year with another." There is provision for reviewing any charges scheme from time to time.

The scheme(s) when prepared, must be published in the form directed by the Transport Tribunal and representations may be made by interested bodies thereafter. Competitors have a right of complaint if the proposed charges are too low.

After the time for lodging objections has elapsed, the Tribunal must hold a public enquiry at which it shall hear the Commission and those who have a right, or have permission to be heard, after which it must confirm, alter or reject any scheme submitted.

Part VI of the Act deals with the compensation payable in respect of the acquired undertakings. British Transport Stock, guaranteed by the Treasury, was created and issued in satisfaction of any right to compensation in respect of all undertakings taken over or acquired. The sum payable in respect of any undertaking providing port facilities was limited to the value of their securities on certain dates, British Transport Stock being issued for the equivalent value.

To date (1951) the Executive on behalf of the Commission has made reviews of the principal trade harbours in the following areas:—

(1) River and Firth of Clyde and Ayrshire Coast.
(2) River Tees and the Hartlepools.
(3) River Tyne, Blyth and Warkworth.
(4) Sunderland and Seaham.
(5) River and Firth of Forth.
(6) Aberdeen.
(7) Dundee.
(8) Merseyside, Manchester and Preston.
(9) London.
(10) Bristol and Avonmouth.
(11) Cumberland.

In all cases the Executive had discussion with the representatives of the users and the workers actually employed in the " trade harbour " concerned and met members of all the port authorities affected.

A scheme was submitted in the case of Tees-side and the Hartlepools, as a result of a request by the Minister of Transport for a report on port facilities in that area, following on the submission of a plan involving large capital expenditure on new deepwater berths at Lackenby.

Other schemes put forward by the Executive at the request of the Commission was one for the River and Firth of Clyde and the Port of Aberdeen.

In all these cases the Commission has announced its intention to exercise its scheme-making powers under Section 66 of the Act and are now (1951) taking the appropriate steps.

4. The Chief Sources of Revenue of Port Undertakings.

Revenues from shipping, goods handling, warehousing and storage of goods. Other miscellaneous sources of port revenues.

Previous articles in this series have indicated that a port authority's sources of revenue are many and various. Those derived from three main branches of activity, viz.: tonnage dues on shipping, charges for goods handling and rents for warehousing and storage of goods easily head the list, all other items being usually quite small.

Tonnage dues on shipping is in most ports the main item of revenue. These dues may be divided (where a river or estuary has to be passed to enter docks) into river dues and dock dues. Some ports charge a combined due, others separate them. Some authorities " zone " their river dues schedule, charging according to the distance a vessel ascends the navigable river, whilst others charge the highest due on vessels arriving from the furthermost port from which a ship begins her inward voyage. The assumption is that the number of calls made at the port in one year will be less than those of a vessel having commenced its voyage from a nearer place. All ports make considerable reductions to ships trading coastwise.

The tonnage due is levied in U.K. ports (and practically all over the world) on the nett registered tonnage of the vessel, certain additions being made to this figure when cargo is carried in a shelter deck and/or on deck.

The nett tonnage figure in the case of British ships is given on the certificate of registry (it is also marked on the main beam of the ship itself) which has to be exhibited to the Customs on entry inwards. Inward tonnage dues collection in many ports is linked with Customs formalities, a ship not being " cleared outwards " unless the Port Authority's stamp (or other agreed indication) has been placed on the documents lodged.

River tonnage dues on ships cover the operating interest and capital costs of providing and maintaining conservancy and training works, dredging, wreck raising and removal, sometimes certain channel buoyage and lighting, provision of certain mooring buoys, etc., facilities for loading or discharging vessels in midstream, fixed and floating landing stages, piers and jetties. It also covers the cost of the dissemination of charts and the important hydrographical information about the port, for service of all rivers users.

Dock tonnage dues cover the operating interest and capital costs of providing and maintaining enclosed docks (and basins) with their locks, quays, cranes, warehouses and sheds, etc. Due to

Port Organisation and Finance—continued

the greater capital involved and higher maintenance costs, the dock due is usually higher than the river due.

Both dues cover the use by the ship for a certain period, of the fixed port facilities provided, and do not include any charges for services rendered, such as towage, pilotage, drydocking, bunkering, cargo handling, etc. If a vessel stays longer than the period allowed, a rental charge, at so much per registered ton, is levied.

Charges and rates on cargo handled either inwards or outwards through a port are legion, varying with the commodity, etc., handled. The basis on which they are levied also varies. The commonest is on the tonnage weight of the goods themselves (as declared on the inward Bill of Lading or the outward Shipping Note.) Often the cubic measurement or the package unit (i.e. bale, bundle, etc.) forms the basis.

Free warehousing for a certain period is included in some rates for commodities commonly warehoused, a weekly rental charge payable per ton or unit being levied for any period exceeding. Frequently the importer pays landing and warehousing charges. If he sells the goods to a merchant who cannot take delivery before the expiry of the free rent period, the buyer must pay the warehouse rent on them.

Extra operations on imported goods are many and various. " Trade customs " such as charging weighing to buyers' account, etc., have often to be observed by quay and warehouse staffs when dealing with certain commodities.

Export cargo is charged a wharfage (or use of quay) rate when ships' gear lifts it aboard, with a porterage rate in addition where the goods are actually put on board by dock crane. Export goods taken overside may pay a small charge. Extra operations on export cargoes, weighing, opening for Customs, etc., are chargeable in addition.

Special rates, based on tonnage lifted and time occupied (whether for import or export cargo) are charged if a port authority's heavy crane is employed, while an ad valorem charge is made on packages of precious stones, specie, bullion, etc., placed aboard. There are special contract rates for G.P.O. mails and parcels.

Port revenues from other sources are very miscellaneous. Certain authorities perform all internal dock towage on ships, leaving river towage to outside firms. Rents of land and buildings (sheds, offices, warehouses, etc., are often let to persons or firms having business in the port) wayleaves, charges for abstraction of water, ferry charges, licensing of tugs and lighters using the waterway are a few.

The Docks Executive and certain of the " trust " port authorities have power to grant licences for persons and firms wishing to erect, use, or lease river wharves or dock quays, mills or jetties for ship and cargo working within their jurisdiction. Additional revenue is secured in the case of one or two trust type ports by a toll or general levy on all cargoes (whether inward or outwards) using the port. The London " Port Rates," the Liverpool " Dock and Town Dues " are examples. Collection is linked with Customs entry.

Ports are given legal powers under their Acts for collection of dues on ships and charges on goods. Certain clauses are incorporated into each private Act giving the undertaking power to hold either ship or goods until all dues and charges are paid, and they have a lien for their charges whilst goods remain in their custody. In the last resort the goods may be sold, the amount due together with the costs of sale, etc., being deducted from the proceeds, and any balance returned to the owner. Usually an official known as a Collector of Dues is named in the Private Act as being vested with certain powers (codified and adapted in each case from the Docks and Harbours and Piers Clauses Act 1847) which can be put into operation against a defaulting vessel, and he may also be made responsible for collection of the charges on goods. Such an appointment may be combined with another office (often the Secretary or Treasurer) in the port organisation.

Dues and charges are the means by which U.K. ports meet competition between one another and the nearer European Ports. Theoretically, they are framed either on the basis of what it is considered a particular traffic will bear, having regard to competition and volume or on the comparative value of the goods themselves. They are revised continuously throughout a port's existence, so that receipts from charges and dues will produce annually an amount sufficient to enable the port to meet its operating costs and expenses and cover interest and sinking fund charges. The building up of separate tariffs for goods and dues schedules for ships and for the multifarious operations that ports as warehousekeepers, etc., carry on on behalf of merchants is so framed that as far as possible each activity is profitable year by year. It is seldom possible to ascertain with any degree of accuracy what the cost of handling any one commodity is, unless one knows beforehand the total tonnage handled, so that the overhead and supervision charges can be divided up and allocated.

Comparisons between two different port tariffs cannot be made unless one is well acquainted with the services performed and covered by each rate under comparison. If it is desired to attract a trade to a port certain rebates, discounts or perhaps additional facilities not normally covered by the tariff may be offered by the management of the port as an inducement to make use of the facilities provided.

The general policy laid on the Port Trusts by their Acts is to see that all expenses are covered, no profit making being allowed. If in any year a working surplus should accrue as a result of trading operations, it must be applied to the reduction of rates and charges, after all proper claims have been met, including interest on the issued stock. The Docks and Inland Waterways Executive is under a similar obligation.

Wide powers are given by Parliament to Port Authorities to safeguard and ensure their revenue. Thus the Port Collector of Dues may board vessels (i.e. commit what ordinarily would be a trespass) in his search for the proper nett tonnage and number of a vessel. Ports as warehousekeepers are responsible to merchants for the proper custody and correct delivery of goods entrusted to them, and they are given a lien for their costs and charges. They have duties to shipowners and other users of the port, and very often duties to the public (provision and upkeep of road bridges, etc.). They are protected against certain of the commoner trading and business risks by possessing powers not normally granted to a trading corporation however large.

Parliament does not grant these powers without adequate safeguards, and the Minister of Transport is appointed to supervise the working and act as arbitrator by most of the private Acts, in the event of disputes arising between the authority and the public. Submission of the annual report and accounts to the Minister is another safeguard, allowing the current trading position to be watched.

Company owned ports have their own special Acts or orders (made by the Minister of Transport) setting out the terms and obligations under which Parliament has permitted the dock or undertaking to be constructed and operated. Their public duties may be small, their main business being trading for profit, but the safeguards given them in their Acts are usually similar to the bigger authorities. Their officers, as in the case of the larger ports, work under the direction of a specially appointed official (such as a General Manager or a Secretary) who is directly responsible to the Board.

5. Main Trends of Expenditure and Collection of Revenue.

Principal items of working, maintenance and capital expenses.

Procedure in Collection of Revenues and Payment of Expenses.

Current charges (i.e. wages, salaries, stores, fuel and such incidentals as national insurance, contributions to the National Dock Labour Board funds, etc.) are the main items of expense of a port or dock authority however owned. Experience shows that such costs cannot be much reduced, indeed at the present time they are continually tending to rise, making increases in dues and charges necessary if they (particularly wages) exceed a certain margin. A rise in dues and charges may have the effect of driving into a competitive U.K. or Continental port certain traffics that perhaps are held by only the narrowest of margins. Most ports can count on their hinterlands to absorb a considerable quantity of foodstuffs that tend naturally to gravitate to the port. If the port is in competition with another in the same, or a close adjoining, consuming or producing area the keenest competition arises.

Port Organisation and Finance—continued

Most Private Acts lay upon the port authority (often referred to as the " undertakers ") certain duties which the body was specially authorised to do or for which it was brought into being. Thus the Port of London Act lays upon the Authority the duty to provide and maintain a dredged channel of certain stated dimensions in the River Thames from the Nore (the port's eastern limit) to Gravesend, which has to be kept open and safe for shipping to use at all times.

Another factor affecting capital outlay is the class of goods handled. Thus on the Tyne and Wear, gravity allows coal wagons to be handled easily on to and off some of the tips, the river banks permitting gravity " runs " down from the yards to the loading appliances. At Cardiff and the South Wales ports the loaded wagon sidings being on the same level as the quays, the wagons have to be run singly on to large lifts, raised to 60-ft. or so above quay level and tipped.

A heavy item of expenditure in certain ports is the cost of improvements and maintenance of their approach channels by artificial training banks or " walls." The channel leading through the sandy bar in Liverpool Bay was protected by dumping thousands of tons or stone to form "training banks " on either side. The water passing to the sea is "trained " through this narrow channel to keep it open as far as possible by scour. The " training walls " also prevent spilling of sand from the surrounding banks into the channel by cross currents. River piers, jetties, etc., built on the banks of rivers having a large tidal range also involve a high capital cost, due to the greater length of piles, sheeting, etc., used in the building.

All the foregoing represent items of capital expenditure and maintenance vital to the port's existence. Any expense spared in first cost of maintenance might severely handicap the work of the port. Neglect would put it out of business.

The balance available for the undertaking to meet interest on stocks, charges on debentures (if any) provide funds for the redemption of any redeemable share capital after a term of years, and to finance certain other funds, is that difference between gross receipts and the payment of all working expenses.

Ports and Dock undertakings cannot as a rule provide for capital improvements such as new docks, channel training schemes or deepening projects, etc., out of revenue, as some industrial undertakings can certain of their capital equipment. The costs of port capital works are so great that even if spread over a number of years the burden would be crippling. Nowadays British ports are in competition with one another as they will always be with certain of the Continental ports) and increasing dues and charges may drive traffic away especially if currencies abroad are depreciated.

Most of the methods of collecting revenue employed by Port undertakings have already been indicated. All payments out are subject to check by some form of internal audit in the Accountant's Department, the actual items being paid by cheque signed by or on behalf of an official known as Treasurer or Cashier. Overall control of expenditure is by means of an annual budget usually furnished to the Board by the Chief Executive together with his analysis of the current trading position, in order that as far as possible no demands are likely to be made to affect the solvency of the undertaking during the ensuing year.

Custom House, London

Historic Architectural Feature

By R. ALEXANDER

The Thames, despite strong competition from the Mersey and the Clyde, remains the principal commercial waterway of Britain, and no one who has business on the Thames should be ignorant of the Custom House.

Situated hard by Billingsgate, the oldest wharf in the City of London, it is both a fine architectural feature of the Pool and a symbol of the international commerce which has made London the first city of the world.

There seems to have been a malignant Fate watching over London's Custom House. For the present one was severely damaged by enemy action in the last war, and its predecessors were all destroyed by fire.

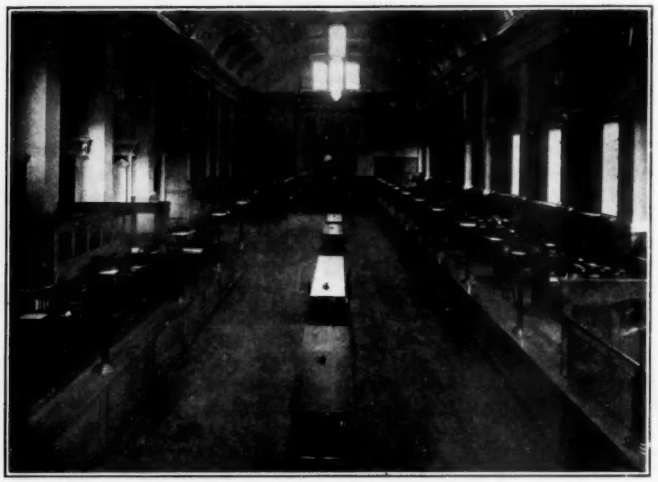
The earliest known Custom House was built by John Churchman in 1385 on the site of the present building, but little is known about it.

The second building, which was erected in Elizabeth's reign, was totally destroyed in the Great Fire in 1666. Sir Christopher Wren designed its successor which was burnt down in 1711, and was the only one of his buidings to be destroyed in his lifetime.

The fourth was designed by Ripley who created the " long room," although some attribute this conception to Wren. At any rate, the Long Room has become not only the distinctive feature of London's Custom House, but has become the generic name of all rooms in Customs Houses throughout the Empire, where customs entries and shipping bills are presented. This may have baffled many a traveller who, having been directed to the Long Room at some small port, was surprised to find himself in some squalid little office.

On January 12, 1814, Ripley's building was set on fire accidentally by the housekeeper, a Miss Kelly, who seems to have been an odd sort of character. She occupied an apartment, rent-free, in the best part of the building, together with numerous pets and often held musical entertainments in the Long Room.

The fire spread quickly and touched off a store of gun powder. Documents were scattered by the explosion and carried across the City by the high wind. Soon the building was a total loss and two servants of Miss Kelly were burnt to death.



The Long Room after restoration 1951.

A magnificent building was planned to take its place with a front comparable to Somerset House. Over £41,000 was spent in buying freeholds to extend the old site.

Eventually, under the direction of Mr. Laing, the Government Architect, the new building was erected costing nearly three-quarters of a million pounds and completed in 1817.

It was soon the subject of controversy, for the foundations were insecure and in 1825 the Long Room fell in bodily. The Crown fought an unsuccessful action for damages against the contractor, a Mr. H. Peto.

Rennie, the famous designer of old Waterloo Bridge, undertook the reconstruction, and his Long Room remains a monument to his skill and imagination. Measuring 199-ft. by 66-ft., with no intermediate supports for the roof, it is a magnificent room.

The east wing was destroyed by enemy action in 1941, but the Long Room escaped serious damage. It has just been redecorated and re-occupied by H.M. Customs. It is well worth a visit during business hours (10 a.m. to 4 p.m.).

Emerging once more from retirement, it pulses with life and seems to typify the indomitable spirit of enterprise and commerce that has ever been the source of London's greatness.

Freight Handling

Review of the Report of a Specialist Team which visited the United States of America in 1950

(continued from page 180)

The first instalment of this Review, which was published in the October issue, gave the terms of reference of the Specialist Team and details of their Report, dealing with Sections 1 to 3 and the first part of Section 4. The Review of the remaining part of Section 4—Mechanical Appliances used in Terminal Handling—and Sections 5 to 7 are printed in this issue, together with the conclusions and recommendations of the Team.

Port Working.

" Before embarking for America, copies of the " Report by the Working Party on increased mechanisation in the United Kingdom Ports " were circulated, and although the Team was not charged with the duty of carrying out the study referred to under Recommendation (7) and, in fact, had no opportunity of extending its tour to include Canadian ports, the desirability of keeping before it the conclusions reached and the recommendations made in that Report was kept in mind." . . .

For the benefit of those not conversant with the above-mentioned working party report, Recommendation (7) was as follows : " A study should be made at an early date of the equipment used and the methods of work employed in the major ports of the United States and Canada." Many of the points referred to in that report are dealt with in the Report of the Freight Handling Team.

" **Equipment of Piers.**—Except for a few heavy lifting cranes installed at particular quays, all the ports visited in America rely almost entirely upon ships' gear for loading and discharging cargo." . . .

The Report continues with a reference to the difference of opinion as to the relative merits of quayside cranes compared with the use of ship's gear, and mentions one American view of the matter—the contention that, when a quay equipped with quay cranes is idle an appreciable amount of capital is earning nothing. While this is true, the same, of course, can be said of the quay itself, and the sheds (if used merely for transit purposes) besides all the other quayside equipment. If the quay cranes accomplish the discharge or loading of vessels in quicker time than ships' gear, however, they will " earn their keep " over a period of time and a matter of a few days' idleness is of no great importance. A necessary proviso to this line of argument is that a proportion of the benefit of the quicker " turn-round " of the vessels accrues to the Dock Authority.

The Report briefly describes the usual American methods of overcoming the limitations of ships' gear in relation to outreach and height—Cargo Cranes, Cargo Masts and Burtoning, and adds—

" The cost of installing and maintaining such equipment would be very low in comparison with the cost of equipping the piers with cranes, but, while effective, it has neither the manœuvrability nor the flexibility of modern luffing quayside cranes.

" For heavier cargo, American ports rely almost entirely upon floating cranes and derricks and, as in the case of most other port equipment, these are owned and operated by the pier operators themselves or by contractors, few if any being owned by port authorities." . . .

Readers will be interested to learn that the Report devotes some considerable space to the inventions of Captain V. C. Farrell, which were the subject of an article in the "Dock and Harbour Authority" of August, 1950. These are the Co-ordinated Rolling Wing Deck Ship Construction, improved Burtoning Cargo Gear, and the Positive Load-Control Ships' Crane.

This question of quay cranes versus ships' gear appears to be most difficult of clarification, and there is, as yet, no general indication of the lines upon which the solution will lie. There is, however, a definite tendency towards the improvement of ship-cranes or derricks, but here the American contention concerning the unproductive idleness of cranes seems likely to apply, for it can be argued that it is uneconomical to provide ships with expensive cargo handling cranes if the voyages are long. Moreover, such gear is not generally required at European ports or at the majority of ports elsewhere.

Timber Carriers.—The Team apparently had the opportunity of seeing the discharge and storage of timber cargoes at one place only. Here the type of appliance, the " Straddle Truck," well known in Britain and in use at some timber yards and ports, was in use.

Ore-Discharging Plant.—Here again the Report suggests that one plant only was visited. The equipment used there was of a type used at some British and many Continental ports, being merely a movable gantry over which grabs traversed between ship and ore dump.

Readers will remember that, from May to October, 1950, a series of articles entitled " Some Modern Cargo Handling Appliances " appeared in the " Dock and Harbour Authority." The articles gave a comprehensive review of the mechanical equipment in use at a number of British ports.

Road and Rail Equipment.

Items of interest more directly related to road transport were : devices for equalising height of road vehicles and loading banks, anti-pilferage curtains and tachograph recorders on vehicles.

The rail equipment examined by the Team was more particularly that in use at railway terminals and depots and is not of much interest to dock authorities. However, a motorised type of hand-barrow would appear to have possibilities in docks.

" One tested recently by the American Navy was a heavy-duty, two-wheeled hand truck (with an additional small third auxiliary wheel to support the load), powered by a single-cylinder, four-cycle, one-and-one-half-horsepower petrol engine. The engine is started by means of a kick-starter.

" The view expressed after tests had been made was that there appeared to be a definite place, under certain conditions, for a motorised hand truck in materials-handling operations. In single movement of loads there is little difference in time between the use of the motorised hand truck and that non-motorised. There is, however, less expenditure of effort by the operator using the motorised truck and therefore, over a full day's operation, more work should be accomplished with the equipment." . . .

Fig. 7 is a drawing of the appliance.

5. CONTAINERS

" While in Britain there is an appreciable and growing use of freight containers capable of being transferred by means of cranes between road and rail vehicles with, among other advantages, the avoidance of intermediate handling of individual packages and saving of packing, containers are not used to the same extent in America.

" It appears that in America about 35 years ago there were developments in the use of large container units—12,000-lb. capacity—about one-fifth larger than the lift-van type in use in Britain. Their operation was not considered to be very satisfactory and gradually they have been abandoned.

" In some instances containers are in use for sea-borne traffic. These generally are of the nesting type. They are pressed-metal welded containers permanently fitted with a bed of 4-way pallet formation for handling by fork truck; lifting rings or holes are provided in the corner posts to permit cranage. The top and bottom faces are so arranged as to dovetail into one another in order to prevent displacement when stacked. Their use is principally by shipping firms running regular coastal services between ports where

Freight Handling—continued

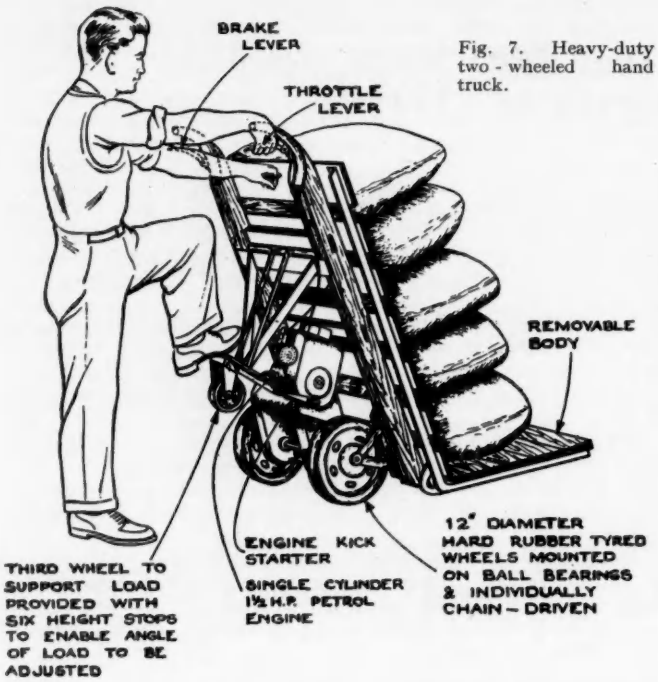

BRAKE LEVER
THROTTLE LEVER
REMOVABLE BODY
THIRD WHEEL TO SUPPORT LOAD PROVIDED WITH SIX HEIGHT STOPS TO ENABLE ANGLE OF LOAD TO BE ADJUSTED
ENGINE KICK STARTER
SINGLE CYLINDER 1½ H.P. PETROL ENGINE
12" DIAMETER HARD RUBBER TYRED WHEELS MOUNTED ON BALL BEARINGS & INDIVIDUALLY CHAIN-DRIVEN

Fig. 7. Heavy-duty two-wheeled hand truck.

the terminal arrangements are in the control of one firm, facilitating their return either loaded or empty.

" These welded containers are built of heavy corrugated sheet steel, with double doors on one side made of the same material."

Fig. 8 shows the " Dravo " container, the particulars of which it may be remembered were the subject of an article in the August, 1949, issue of this Journal.

" A deal of thought is being given in Britain to the possibility of devising some simple, efficient and inexpensive means of transfer of containers between road and rail vehicles, other than by crane power.

" Equipment has been designed and patented in America to facilitate the transfer of containers between road and rail, but transport undertakings do not appear to be seriously interested because of the comparatively small use of road-rail containers." . . .

The Report mentions the difficulties arising from Customs examination requirements, in the reception in America of sealed containers from Britain and elsewhere. These difficulties, however, the Report explains, may be resolved when a Bill, now before the American Legislature, is put into its final form and passed by Congress.

6. TERMINAL DESIGN AND LAYOUT

The Report states that, in broad lines, the respective layouts of rail, road and dock terminals did not reveal any fundamental differences between the two countries.

" The modern tendency in the construction of distribution centres and warehouses was towards single-storey buildings with the minimum number of pillars in the floor area and well adapted for the free movement of fork trucks and the stacking of traffic to a reasonable height.

" At an older type multi-storey warehouse—the U.S. Army Base at Brooklyn, erected in 1918—an interesting method of minimising the number of lifting appliances was seen (Fig. 9). Two overhead cranes working on one gantry are used to serve two large eight-storey warehouses, one on either side of the crane race. Each warehouse floor can be served at nine points and traffic can be transferred directly between road or rail vehicle and any of these points. Verandah loading platforms (pockets), approximately 8-ft. long and 6-ft. wide, with 2-ft. 6-in. high safety wall, are cantilevered out from the side of each building in echelon formation as indicated on the diagram. There is sufficient room for a man to stand in the " pocket " to receive or despatch a standard U.S. Army pallet 6-ft. × 4-ft. and remove or attach slings." . . .

" Finger-Pier " Principle in Marine Terminals.

" In regard to freight terminal layout in docks, at all ports visited the comparatively small difference in depth of water at any state of tide, coupled with the availability of ample water space, has led to the development of open ports instead of enclosed docks where the water has to be held up by lock gates as is general in Britain. This has played a fundamental part in American dock development, both in connection with the actual layout of port properties and their equipment. With few exceptions, e.g., New Orleans, all principal port accommodation at the ports visited has been developed on the " finger-pier " principle, that is to say, berthage for ships was provided by building piers out into open sea or rivers from the mainland. These piers vary in length up to 1,400/1,500-ft. and in width up to approximately 500-ft. Except in the comparatively few cases where open piers are in use for bulk or specialised traffics, the surface area of these piers is almost entirely covered by single- or double-storey sheds, leaving in most instances only narrow shed aprons upon which to receive cargo from ship or upon which to make up goods for shipment. This, too, has had an important influence upon the types of mechanical equipment in use at American ports.

" Another feature of this type of port development which was particularly noticeable in New York is that it provides little or no land behind the port for the accommodation of ancillary port services such as " holding " sidings for railborne traffic, parking area for road vehicles, and/or warehouses for long term storage, etc. The surface area of the piers, therefore, has to meet all requirements despite the fact that many of the piers were built many years ago when transport was in its infancy and when the volume of traffic offering was appreciably less than it is to-day. Greater scope for developing mechanisation of cargo-handling processes would be hard to find, because the intensified use of the restricted land areas by increasing storage height and the quicker movement of traffic on and off the piers would appear to be the only readily available means of increasing capacity and minimising congestion."

There was, therefore, little to learn from a study of " finger-piers " and the Report states :—

" On the general question of port layout interesting information was forthcoming at Boston, where the Port Authority have extensive development plans in view. One of these was stated to involve a complete departure from the existing finger-pier type of accommodation, because more room behind the quays was required for the development of warehouses, etc. Plans were therefore being prepared, based on building lateral quays along the waterfront now occupied by old piers Nos. 3 and 4, and consideration was being given to equipping the new quays with cargo cranes instead of relying entirely upon ships' gear as hitherto.

Shed Design and Equipment.

" So far as structure is concerned, dock sheds in America vary little from those at most British ports. Many of them were constructed so that by means of roller shutter doors the sides of the sheds could be almost completely thrown open to the waterside. At all the newer sheds inspected provision was made for rail traffic inside the sheds by means of depressed or sunken tracks, thus bringing the wagon floor down to shed floor level. In all cases where such provision was made, the the sunken tracks were bridged at convenient places for the free passage of mechanical appliances, the bridges being in most instances readily raised to under-roof height by electric machinery.

" At some ports where two-storey sheds were installed roadways were " ramped " up to the upper floor to facilitate dealing with road-borne traffic.

" It was obvious that the weight of mechanical handling equipment used in some of the older sheds was having its effect upon shed floors, the condition of which left much to be desired. In newer sheds, however, this problem appeared to have been solved, as most of them provided good surface for the operation of mechanical plant. What appeared to be an excellent floor in the newest shed

Freight Handling—continued

inspected was stated to be constructed of concrete with a 1½-in. top of bituminous concrete.

" In most cases it is the practice to allow road vehicles to drive into the sheds for loading or discharge direct into storage; in fact, at New York, where only one of the many railroads directly serves Manhattan, a comparatively small proportion of the total tonnage dealt with is handled direct between rail and ship or shed.

" The type of door most commonly used in warehouses and depots is the roller shutter, mainly chain-operated but, in more modern buildings, power-driven for very large doors. Sometimes use is made of an alternative arrangement whereby the weight of the door is balanced in such a manner that one man can raise the door, which slides first upwards and then horizontally in suitably shaped channels.

" A common feature of buildings in America is the installation of fire precautions, and all newer dock sheds were provided with overhead sprinkler systems, whilst some were also provided with baffle aprons of corrugated sheet attached to the roof trusses to act as draught-breakers in the event of fire."

7. LABOUR IN FREIGHT HANDLING TERMINALS

Port Working.

" It is the normal practice in the ports visited for what is commonly regarded in Britain (with various qualifications) as port transport work—that is the process of transferring commodities between road or rail vehicle or shed and ship's hold, or vice versa—to fall into, broadly, two stages. Thus the carrier, which may be the railroad company and is frequently the owner or lessee of the pier, is responsible for the master porterage, that is the loading between vehicles and shed floor, while the stevedoring employers, on behalf of the shipowners, contract for the loading and unloading of the ship. The line of division varies somewhat between the ports, and the processes involved are, of course, complementary, and similar in certain aspects. They may, however, in respect of this division, present considerable difference in conditions of employment. The master porterage on behalf of the carrier is done by labour employed under conditions negotiated by the terminal operator with the appropriate trade union, while the stevedoring work is done by longshoremen governed by agreements between the port employers and the local agencies of the International Longshoremen's Association.

" With some exceptions, both classes of labour are casual, but it is usual for an employer to have men who follow his work as far as possible, even to the extent of largely depending on it for their livelihood. On the stevedoring side especially there is a superabundance of labour; the average daily employment in the Port of New York is apparently little more than 60 per cent. of the number of men available. There is no registration scheme comparable with that in the dock industry in Britain and accurate employment statistics are lacking. Men are selected and engaged at recognised calling-on places and are employed for a half-daily guaranteed period of 4 hours (8 a.m. to 12 noon; 1 p.m. to 5 p.m.). The normal working week is 40 hours, Monday to Friday. . . .

" So far as could be ascertained all work, whether ship or quay, is on a time-work basis without bonus or other incentive.

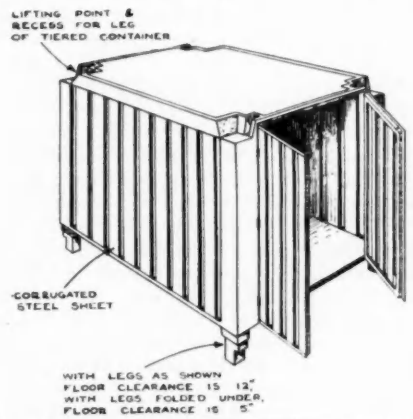
" The ship and quay gangs, that is, those concerned with the actual loading to and discharging from ship, were composite gangs, with a basis of 21 men. Lesser complements were engaged in certain cases of bulk cargoes. The manning of shed and warehouse gangs varied considerably according to the operation.

The effect of mechanisation on the two classes was different. In connection with work to and from vehicles the employers have been able to make manning adjustments which were considered reasonable to meet the new methods of work, and examples of such reductions arising from the introduction of mechanisation were quoted. On the stevedoring side, however, whilst the use of mechanical equipment was not opposed, the union would not agree to any reduction of the basic gang, but to meet the increased speed of work on the quay the disposition of the men in the composite gang could be altered. Even so, some of the employers were not dissatisfied with the situation; since all work was on a time basis any speeding up of the operation must result in the employer obtaining the benefit of increased output for the same wages outlay.

" The Team was unable to secure adequate figures to show the effect of mechanisation on output although some striking examples were given of increases obtained by this means. In some cases extraordinary outputs were achieved, which would seem to have been due not so much to any high degree of mechanisation as to sheer hard work arising, it was concluded, from the casual system of employment, the competition for jobs and the keen supervision. Another notable factor is that employers have regular followings of men under their own foremen or supervisors, through whom the employer engages the labour.

" Mechanical equipment is used extensively in the ports visited in America. It would be fair to say that the development of mechanisation has proceeded with very little friction, being accepted by men and employers as progressive and more or less inevitable.

" Mechanisation has resulted in the speedier and more economic handling of cargo and it has enabled the fullest use to be made of shed accommodation."


LIFTING POINT & RECESS FOR LEG OF TIERED CONTAINER
CORRUGATED STEEL SHEET
WITH LEGS AS SHOWN FLOOR CLEARANCE IS 12"
WITH LEGS FOLDED UNDER, FLOOR CLEARANCE IS 5"

Capacity ..	12,000 lb.	6,500 lb.
Length	7ft. 9ins.	7ft. 0ins.
Width	6ft. 5ins.	3ft. 8ins.
Height	7ft. 0ins.	6ft. 2ins.
Tare wt. ..	1,710 lb.	1,000 lb.

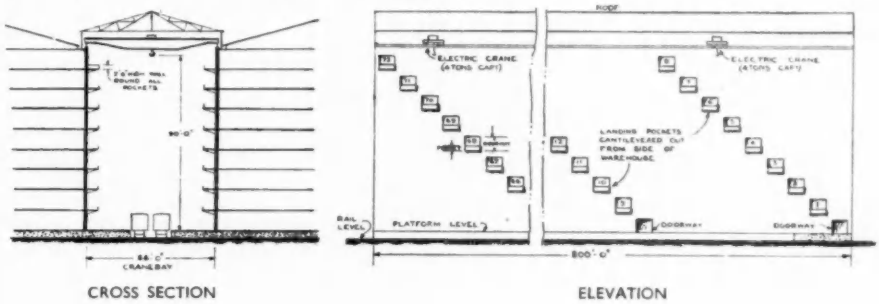
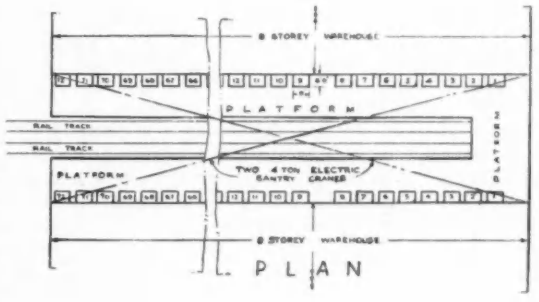


Fig. 8 (left). The " Dravo " container. Fig. 9 (right). Gantry cranes serving multi-storey warehouses. Heavy articles and loaded pallets are withdrawn from rail wagons to platform by fork truck or other suitable means. Traffic for the ground floor of the warehouses is trucked direct; that for the upper floors is craned from the platform to the appropriate " pocket " at the higher level and taken thence into the warehouse by fork truck, etc. The reverse procedure can be adopted when dealing with traffic from warehouse to rail wagon.



Freight Handling—continued

Section 8 of the Report, Recording of Vehicles at Terminals, is of no great interest to Dock Authorities and is therefore excluded from this Review.

CONCLUSIONS AND RECOMMENDATIONS

The Report ends with a number of conclusions and recommendations from which the following excerpts are taken :—

Conclusions.

" The Transport Operator's capacity to handle traffic is often limited not only by the size of the vehicle or ship in which the goods are to be transported but also by the size of the depot or shed in which the transfer of traffic from vehicle to vehicle, or from vehicle to ship, is effected. In these respects there is no basic difference between the problems confronting the American transport operator and his British counterpart.

" It is therefore not surprising that, in observing American methods of freight handling, whether in rail, road, dock or traders' premises, no startling difference in the standard of achievement in the two countries is apparent. There are, however, important variations in technique, in the attitude of mind to mechanisation, and in the degree to which particular methods of handling, common to both, have found favour in one country more than the other, which deserve close study.

" The use of mechanical equipment (in America) is both encouraged by managements and generally accepted by employees, who normally have a fundamental objection to any unnecessary expenditure of physical effort where a machine or contrivance can be used to avoid it. On the docks side, it is well illustrated by quotation from a clause of an agreement between the New York Shipping Association and the International Longshoremen's Association which, in relation to the general working conditions for dock labour, provides for " making the best use of the skill and aptitude of the workers, applying available mechanism and motor power to minimise wasteful manual work."

To the argument that mechanisation makes life easier for the operator should be added the theory, which is frequently expressed by Americans, that the introduction of such modern equipment will of itself help to create fresh demands for the services of the operator by whom it has been installed. Whilst the cost of the equipment is naturally taken into account, the returns on it are calculated not merely in the narrow sense of money but in the wider sense of adding to the firm's general resources and improving the working conditions of the staff.

" While there is little difference between Britain and America in the capital cost of the more general types of mechanical equipment for the handling of freight, American wages are much higher. In consequence, the greater potential saving in wages affords more scope to the Americans for the employment of mechanical appliances. There is an additional point which applies more particularly in the American dock industry; any increased output arising from mechanisation has the immediate effect of reducing handling costs per ton because of the practice of remunerating labour on a time basis.

" Apart from particular refinements and gadgets, and the use of drag-lines, no types of mechanical equipment were seen in use in America for freight handling at dock, road, rail or traders' premises which are unknown in Britain. Mainly for the reasons already mentioned there is, however, a much wider application and more intensified use of such equipment in America.

" In spite of the difficulty of measuring working rates or costs in freight handling, the visitor to America is immediately conscious of a high degree of enterprise, keenness and industry displayed by management and staff in their daily work.

" The control and management of dock labour in America is much the same as it was in Britain prior to decasualisation in 1941. There was an abundance of labour available at all ports visited and normally men were seeking employment beyond the average requirement of the port. The employers, through supervisors, are still primarily responsible for selecting the most suitable men for particular jobs, and engagement lasts only for half-a-day or a full day as required. There was a high degree of keenness and responsiveness to reasonable disciplinary control.

" Despite longer experience in America, progress towards standardisation of sizes of pallets is no greater there than in Britain, and so far as can be ascertained, there is at present no pallet pool in operation in America with general common user and interchangeability.

" The somewhat restricted accommodation offered by the finger-piers so common in American ports has brought about the intensive operation of mechanical equipment to obtain the maximum use of available floor space and ensure fluidity in working; this, in turn, has had the effect of increasing the speed of the ship's turn-round.

" In regard to freight terminal layout, apart from features mentioned in this Report, including pier construction at ports, there is nothing fundamentally different in principle of conception between the two countries. As in Britain, many of the older berths and sheds at American ports are inadequate and incapable of meeting modern requirements efficiently, but newer piers and sheds are well designed and constructed, and compare with modern development at British ports.

" In no branch of freight handling in any form of transport was there any real enthusiasm on the part of management or men for piecework or incentive schemes.

Recommendations.

" 1. The main recommendation—which must necessarily be in general terms—is that all transport interests, including docks and harbours concerned in the handling of freight, and industries or firms dealing with the movement of appreciable tonnages of traffic, should intensify their enquiry and research into the scope for increased use of mechanical equipment, especially those types referred to in this Report.

" 2. Particular emphasis is laid on the potentialities in general transport use afforded by :

(i) Fork-truck operation, either with pallets or, for suitable traffics, pusher or specialised attachments on the fork trucks;
(ii) The development of palletisation and the unit load for throughout transport;
(iii) The drag-line method of mechanising transport depots.

(While a deal of data on all of these is already available in Britain and can be obtained through manufacturers or the technical press, the Team collected a number of descriptive pamphlets and brochures in America, and much detailed information is available for enquirers on application to the Team Secretary, 203, Eversholt Street, Euston, London, N.W.1.)

" 3. Within and between each section of transport, road, rail and docks, also amongst manufacturers and traders, there should be the widest possible dissemination and exchange of information and experience on freight handling methods.

" 4. The attitude and objective of American management towards the maximum use of mechanical equipment in order to conserve man-power, to secure greater efficiency and to reduce physical fatigue, and, on the other hand, the general receptivity of employees to the introduction of such appliances, are features which, despite certain differences in conditions, deserve the closest examination and investigation. In the opinion of the Team the management-labour co-operation on this issue which prevails in America should be followed energetically in all phases of freight handling in Britain.

" 5. In view of the potential benefits to the nation from higher productivity due to mechanisation, trade unions should encourage the development of ' machine-consciousness ' amongst their members and should co-operate actively and earnestly at all levels with local managements in the introduction of mechanical equipment for freight handling.

" Equally, managements should endeavour, by giving a clear explanation of their intention to mechanise, to persuade their employees readily to accept the new methods.

" Both sides of industry should join in publicising the fact that there is nothing new nor frightening in the idea of mechanisation. From the invention of the wheel onwards, it has been an integral part of the national and industrial development. Some new mechanical devices, although perhaps resisted at first, become

Freight Handling—continued

accepted by later generations as contributing to an improved standard of living and to the avoidance of industrial fatigue. In fact, industrial well-being is dependent upon such progress.

" Intensive propaganda along these lines should be undertaken nationally by industry and the appropriate Government Departments in an endeavour to put mechanisation issues in the right perspective.

" 6. In introducing mechanisation just as much attention should be given to the sympathetic and sensible re-deployment of the workers concerned as to the selection and installation of the machinery itself. By local consultation between management and men it should normally be possible either to align each progressive development with the normal rate of man-power wastage or to re-absorb any redundant labour in another part of the industry.

" 7. Although the extension of domestic palletisation to throughout transport is being actively pursued by separate sections of the transport industry in Britain, it is suggested that consideration be given to the establishment of a Central Committee consisting of representatives of railway, road transport and dock interests, manufacturers, traders, the British Standards Institution, and the Services, in order, *inter alia*, to secure the fullest exchange of information and experience on palletisation, to pursue prospects of development and to consider issues of principle.

" The Central Committee, when set up, should have as its principal objective the stimulation of the development of palletisation. For this purpose it is suggested that it should particularly investigate and report on :

(i) Methods of promoting the maximum adoption of palletised or unit loads for throughout transport;

(ii) The best means of securing some standardisation in pallet sizes for throughout transport, having regard to the convenience of both the users and the providers of transport;

(iii) The effect of palletisation on the packing and handling costs of manufacturers, traders and transport providers."

H. F. C.

Colonial Harbours and Wharfs

Some Notes on Recent Developments*

By R. D. GWYTHER, M.C., M.Sc., M.I.C.E.

(continued from page 192)

Excerpts from the Discussion

Mr. R. D. Gwyther, introducing his Paper, said that he had given particulars of the requirements of a port in preference to discussing the details and the merits of the several types of design of wharfs. The three main requirements of a port were: (1) safety against bad weather; (2) ease of approach; and (3) equipment with good cargo-handling facilities. The last, in addition to being adequate, should from time to time be brought up to date in accordance with modern practice. The port authority desired to run the port economically, and to do that it was necessary to pass as much cargo as possible as quickly as possible over the wharf.

He had found it very difficult to obtain figures from different ports of what they were able to achieve; but, generally speaking, the amount of general cargo worked in and out of the port over a wharf in 12 months varied from 150 to 350 tons per linear foot of wharf. A fair average was 250 tons, and at 300 to 350 tons the port would be working at nearly full capacity, although with modern appliances over 400 tons was quite frequently achieved. The figure depended largely on the type of cargo to be dealt with. For instance, imports were nearly always discharged about 1½ times as quickly as exports were loaded, since the exports required to be stowed.

The reason for stating, in the paper, that American engineers preferred apron-widths of 30 to 35 feet, which British engineers would consider narrow, was that in nearly all American ports there was a preference for unloading by ships' derricks, and quayside cranes were not used.

Mr. J. O. Sanders, of Malaya, referring to the question of the single-storied as against the double-storied wharf godown, agreed with Mr. Gwyther that the single-storied transit shed was, in general, preferable to the double-storied shed. At Dar es Salaam, however, where new wharfs were now being constructed, provision had been made for two very large double-storied godowns, one behind each ship's berth. What were the reasons for preferring the double-storied shed? It was not clear whether the sheds at Dar es Salaam were intended to be strictly transit sheds or were also to be treated as storage sheds; the areas given were so large that it might be concluded that a large part of the accommodation was to be used not strictly for transit purposes but for storage purposes. In that case, was it not better and more economical to erect the storage accommodation at a greater distance from the wharf front?

With regard to the double-storied godown, discharge to the upper storey would have to be by wharf crane, since the ship's tackle could not be used for discharge to an upper storey. The result was that a ship's tackle stood idle while wharf cranes, provided at great cost, were manned and operated. What effect had that on the cost of handling the goods?

It was becoming more and more common to provide mechanical equipment for moving cargo from the ship's side into transit sheds or vice versa. Mr. Sanders referred, in particular, to the battery-truck with a lifting platform working with a system of stillages; that equipment had undoubtedly speeded up the handling of cargo and, in one of the largest colonial ports, ships had been prepared to pay a substantial additional charge when such equipment was provided. If a two-storied godown was provided, rather than a single-storied shed, how was the introduction of such mechanical equipment affected? Had there to be a certain amount of duplication on the two-stories, or, if mechanical eqiupment were used, would it not be cheaper to use it to run to a greater distance from the wharf front, rather than meet the cost of an expensive two-storied godown?

Could some particulars be given of the tonnage which it was intended to handle over the two ship berths at Dar es Salaam, relating to the very large size of the godowns which were to be built?

Mr. G. L. Hargreaves, referring to the term " openwork " type of structure, said that he preferred to call it a piled structure. Considerable experience had been gained, during and since the war, in the development and construction of the flat-slab type of wharf or jetty. Its distinguishing feature was that the deck consisted of a reinforced concrete slab several feet thick, with no beams, T-stems, or excrescences of any kind on the underside. The pile-heads were rigidly fixed, the piles formed columns fixed in the deck at the top and in the sea bed at the bottom, and, in general, few or no raking piles were required. Mr. Hargreaves had never constructed the solid type wharf advocated by the Author, and his remarks were confined to the piled structure of which he had had some personal experience.

He felt that the flat-slab type of wharf deserved the attention of the colonial engineer. The design was very simple, clean, and straightforward, a merit which it shared with the solid wall type. The piles were almost entirely vertical and the difficulty of controlling raking piles did not arise. The shuttering for the concrete deck was straightforward; in most cases it was little more than horizontal flat form, which lent itself to simple and robust falsework; it could be constructed almost entirely with unskilled labour. There was adequate space for the reinforcement, which was designed in the form of concealed beams and slabs buried in the thickness of the main slab, and it was possible to have ample spacing between the bars to facilitate working the concrete well in. Finally, the open spacing and lack of awkward corners made it possible to place the concrete in a stiff condition and to con-

*Paper presented to The Conference on Civil Engineering Problems in the Colonies, July 1950, and reproduced by permission of The Institution of Civil Engineers.

Colonial Harbours and Wharfs —continued

solidate it by vibration. Vibrated concrete of a stiff mix was very dense and highly resistant to attach under maritime conditions. When constructed, the deck formed a very stiff horizontal girder, and, in spite of the fact that there might be few or no raking piles, it distributed horizontal shocks throughout most of the length of the wharf or jetty.

His department not only constructed such works, but also had to use and maintain them once they had been built; any errors in design came home to roost in no uncertain manner. Unfortunately, he could give no maintenance facts about those jetties, because they had all been constructed in the past 7 or 8 years, and that was not sufficient time to allow conclusions to be drawn. The Author's type of solid walls had, in many cases, lasted a hundred years or more with little or no maintenance, and possibly the Author could supply some information on that point. Mr. Hargreaves said that two jetties of the flat-slab type, of which he had personal knowledge, had had no maintenance since they were constructed 6 years ago, nor, when last inspected, had they shown the need for any.

A well-made reinforced concrete structure should not need maintenance within a generation or two; he knew of a jetty, constructed about 15 years ago, which had, so far, required no maintenance except in the replacement of fender piles, and, as was well known, naval ships were gluttons for fenders of all kinds. If the concrete work were well made, it should meet all colonial standards.

With regard to cost, it was thought that a piled type of structure should be built for about half the cost of the equivalent solid wall type. It was difficult to compare costs, because the wharf and jetty type of structure had to be measured by the square foot, and the solid wall was almost invariably measured by the linear foot; but, as a matter of interest, the cost of a recent large structure, of the kind in question, was about £4 per square foot. The cost was an important matter, because, even though there might be some doubt whether a structure would last for a hundred years, it might well be that over-capitalization in the earlier stages would act as a handicap rather than as a stimulant to the development of trade. Where the future could not be foreseen for more than a generation or two, it would be as well to employ a more economical structure, with a view to fostering trade, and to rely on the next generation to take further steps which might then prove to be necessary.

He agreed with Mr. Gwyther's remarks regarding bollards. His department had had exactly the same difficulty in dealing with empty tankers at jetties where the T-head was a little longer than the ship, if as long, and the ship had to be controlled entirely by means of springs and braced wires. Something could be done by placing catamarans between the ship and the jetty in the case of tankers, although that was not acceptable for ships carrying general cargo.

He thought that the control of ships at such jetties should be improved.

Mr. Gwyther had made reference to the importance of borings. It should be emphasized that it was of paramount importance to obtain undisturbed samples from borings, because, as pointed out in the Paper, it was possible to misinterpret the description given by someone else and, unless undisturbed samples were obtained and submitted to the shear test and other soil mechanic tests, there was no standard for judging them.

The piled floors of the sheds at Takoradi and Apapa, illustrated in Figs. 2 and 3, Plate 1, were on piled foundations on fill, which seemed reasonable. At Freetown (Figs. 4, Plate 2), however, one side of the shed was on solid ground and the other on fill, and the sheds themselves were provided with reinforcd concrete floors placed on ordinary foundations. What was the reason for that?

He thought that stringent supervision was necessary, particularly under colonial conditions. It had been his experience that, although promoting authorities were willing to expend a considerable amount of money on the best possible designs, they were seldom willing to pay for the supervision necessary to ensure that the intentions of the engineer were put into full effect. It was very important that there should be a first-class resident staff on the job, with sufficient resources and assistance to ensure that the contractor observed every detail of the engineer's drawings and specifications.

Mr. C. C. Marshall, referring to the question of speeding up the turnround of ships, said he understood that the cost of keeping a tramp ship in harbour, at present, was about £300 per day; for a passenger ship the cost would, of course, be greater. Shipping companies would therefore look favourably upon an increase in harbour dues which represented money to be spent on appliances which would save an equivalent amount in the average delays due to turnround. Having regard to the average number of days for which a ship was delayed in harbour, £300 per day would amount to a respectable sum in the course of a year in many harbours of which he had knowledge.

Those considerations had a bearing on the two points upon which he wished to enlarge. The first was the question of lighterage, and the second was the vexed question of single-storied versus double-storied transit sheds.

It was interesting to note that Tanga still used lighters, and was, at present, dealing with about 200,000 tons of cargo per annum. Harbours and harbour engineering were notoriously difficult subjects for generalization; no two harbours in the world were alike. He felt bold enough to suggest that lighters might be the best form of harbour equipment for traffic up to 200,000 tons per annum, and that from that point onwards the provision of deep-water berths became more economical. Even in the most modern harbour, there was still room for a proportion of lighterage.

Some years before the war, Mr. Marshall had been connected with the port of Rangoon, which was not, strictly speaking, a colonial harbour, but had a great deal in common with one. The traffic handled amounted to approximately 1,500,000 tons of imports and 4,000,000 tons of exports per year. The harbour was particularly suited to lighterage, in that, like London, Calcutta, and many other places, much of the traffic was water-borne after leaving the ships. Out of that total of 5,500,000 tons only about 900,000 tons per annum was handled across the wharfs; the rest was handled by cargo-lighters. That was a proportion which might not suit other ports, but he had found that, for the quickest turnround, the best method was to put the ship alongside a wharf, to discharge with wharf cranes on to the wharf, and simultaneously to discharge into lighters on the other side of the ship. That was often possible with modern ships, which had large hatches and were well equipped with derricks and cranes. It might lead to some subsequent nuisance, in that the cargo out of the ship might have been split, some going into lighters to lighter-wharfs and some being collected in the transit shed, the two portions having to be re-assembled later; but his experience had been that, to get the quickest possible turnround of ships, simultaneous discharge over both sides was an advantage. He suggested that, when designing, the total wharf capacity should be split into cargo-lighter berths and deep-water berths in the ratio of about one-third to two-thirds respectively.

Mr. Gwyther had mentioned a figure of up to 350 tons per linear foot of wharf, and had said that 250 tons would be a fair average. At Rangoon, with 900,000 tons per annum dealt with across the wharfs, the figure was about 350 tons per linear foot.

Mr. Marshall believed that once a harbour had grown to the extent of being able to use six or seven berths to full capacity, the time had come to consider converting one or two of the transit sheds into double-storied sheds. Double-storied sheds were of particular use to port-operating authorities which dealt with an import and export cargo, and where conditions were such that the ships came in nearly fully laden and were discharged and reladen almost completely. He thought that double-storied sheds were uneconomical where ships arrived with small cargoes, and stayed only for a day. The Rangoon traffic of 900,000 tons comprised 135 cargoes from non-Asian ports and 770 from Asian ports; the average from each cargo off-loaded was 1,122 tons from non-Asian ports and 560 tons from Asian ports. That showed that, even in a port like Rangoon, usually regarded as a terminal port, the amount of cargo removed from each ship was surprisingly small. There was, however, the " safety-valve " of a very large lighterage capacity in the port, which was used particularly for the specialist trade of rice. That meant that their wharfs could be fully used and occupied, and at certain times during the year ships frequently had to wait for a berth. In a typical year before the war, there

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had been sixty-nine such occasions; the total hours of delay were 1,500, an average of about 1 day for each of the sixty-nine ships. The wharfs in Rangoon were very heavily used and earned their keep; he did not know of any better records of cargo per foot of wharf per annum, were comparative figures available however for Singapore?

Summing up, he thought that in a harbour there was need for a small proportion of lighterage, and that once a harbour had developed up to five, six, or seven berths, one double-storied transit shed was very useful.

Would the Author enlarge on the question of the size of blockwork? He had mentioned a figure of 15 tons, but had also stated that in one instance, the contractors went up to 50 tons to suit their equipment. It would be interesting to know how that had worked out in practice. Designs generally seemed to be of 15, 20, or 25 tons, but 15- and 60-ton blocks were frequently used. Mr. Marshall thought that that was because the heavier blocks were essential in breakwater and mole work and, in harbours where such work had been carried out, the equipment for it was available and so it was convenient to use the same blocks on the wharfs. It would be interesting to know what the optimum size would be where there was no question of building a breakwater or a mole.

Mr. John Palmer, referred to the question of when to change from the use of lighters to a deep-water berth. It was an extraordinarily difficult problem, and he did not agree with Mr. Marshall's figure of 200,000 tons of cargo per annum; he felt that it should be 100,000 tons. That problem had been solved many years ago on the coast of Palestine, where, for 60-80 days a year, the lighters could not work; that had meant a big percentage of time lost, and there were serious losses due to damage by sea water, pilferage, breakages, and so on. When the losses were of the order of 5 per cent. of the value, it was fairly easy to justify the construction of a deep-water berth. In the Caribbean area, however, Mr. Palmer had found that no days were lost at all owing to rough weather, and that the merchants were definite that their losses from lighterage were about 0.5 per cent., so that it was not going to be very easy to justify a deep-water berth there.

The only argument, in the case of the Caribbean, would be on the question of the speed of loading and unloading, which, in that area, was about 7 to 10 tons per hour per hatch. He had tried to reconcile that figure with the figure which both the Author and Mr. Marshall had quoted. Mr. Palmer believed that with a properly designed wharf a figure of 15 to 20 tons per hatch should be obtained, and agreed roughly with the total annual figure which had been given. His own approximate estimate would be 6 or 7 berths per million tons per year. Could any port engineers provide figures of that kind?

The Author had also mentioned the problem of providing deep-water berths at Barbados but had not given the answer. One of the greatest port authority managers in the world had been asked to report on the commercial prospects, and he had adopted the system of saying that the charge per ton of cargo for deep-water berthage would have to be the same as the charge per ton for lighterage and had then worked out what his revenue would be.

Referring to the width of apron in front of sheds, Mr. Palmer thought that Fig. 1 deserved attention. The essential requirement was three railway tracks; one for wagons being loaded or unloaded; another for empties which were to be shunted away, or full wagons waiting to be shunted in; and the third for through traffic between the adjoining berths. There was so much road traffic in the modern port that it was necessary to have a fairly wide space for lorries and other road vehicles; there should be room for a crane as well. All that required a width of nearly 70 feet, and in Fig. 1 Takoradi seemed to be the only port conforming.

On the question of the design of the wall, Mr. Palmer presumed that the ordinary vertical block wall was used where the foundation was absolutely firm and there was no chance of settlement, and that "slice work" (which the Author termed "sloping blockwork") was used where a certain amount of relative settlement was expected during the construction.

Mr. J. C. Lakerides, of Cyprus, referred to the extension of the wharf at Lagos, described by Mr. Gwyther, and to the fact that the design chosen for the extension involved the use of pre-cast slabs. He thought that it would have been easier to drive two rows of sheet piles and use them as shuttering for a mass concrete wall. Such construction would have the advantage of being stronger and, in the event, later on, of having to dredge, the foundations would be much deeper, because the Larssen piles of pre-cast reinforced concrete piles could be driven to any depth required, and it might be possible to reach a solid foundation beneath the sand.

Mr. Gwyther, in reply, said that Mr. Sander's question regarding double-storied sheds had been partially answered by Mr. Marshall. At Mombasa, there were both single-storied and double-storied sheds, and the port-operating authorities preferred the latter. Mr. Gwyther had been through those sheds on more than one occasion, but had found it difficult to decide which was the better. Some ports were operated by the owning authority but, in the case of the port in question, its operation was let out to a private company, and so the officials could not give him much information; he had seen one of the people responsible for operating it and had gathered that they like to build up their cargo in the upper floor of the shed, so that the top floor was really a storage shed and could hardly be termed a transit shed. That also applied to unloading; anything that was going to remain in the port for a considerable time went to the upper storey. Mr. Gwyther was not altogether satisfied that to take cargo from a ship to the top of a building and later, when it was wanted, to lower it to the other side was the best method of working, but there was no doubt that there were ports which found it to be advantageous and which would not work in any other way. At Singapore, where storage sheds were not used, an effort was always made to berth importing and exporting vessels alternatively.

The new wharf at Dar es Salaam was to be extended to 1,800 feet to provide a berth for the Belgian Authorities. The tonnage provided for on the two berths of 1,200 feet was 300,000-400,000 tons per year.

Battery trucks and mechanised equipment were becoming popular, but he did not know if it had yet been determined how far the mechanically-operated truck could be run economically. There must be some limit to the distance. To run from the apron into the shed on a good surface was very different from running across railway lines and perhaps on a poor surface to a transit shed at the back.

Mr. Hargreaves had made out a good case for the openwork type of structure. Mr. Gwyther favoured the slab-type of construction for an open jetty such as Mr. Hargreaves had described, but considered that such a structure had a limit of about 24 feet depth alongside at L.W.O.S.T. When dealing with piles, however, it was probably no exaggeration to say that half the piles were damaged or cracked by the handling they received before they were driven. With regard to the cost of solid walls, he had stated in the Paper that there was not much difference in price. When working out those figures he had been contemplating a piled structure with several rows of piles and bracing. The lighter type of structure which had been developed was, no doubt, cheaper than the old-fashioned type of open structure. The solid wall with 33 feet depth alongside cost from £300 to £450 per linear foot, excluding such items as the filling behind, dredging in front, and so on.

Mr. Hargreaves had asked a question about the piled floors of the sheds illustrated in Figs. 2 and 3, Plate 1, and Fig. 4, Plate 2. In all cases, the load on the ground floor was taken by the ground and not by the piles; the piles supported only the load on the upper floor of the double-storied sheds. The diagram of the shed at Freetown might be misleading, because the top storey there did not carry cargo, but was used as offices by the shipping companies and port officials, the medical authorities, and so on; the load which would exist with a shed containing cargo was not, therefore, involved.

Mr. Gwyther agreed with Mr. Marshall that there was still room for a proportion of cargo to be moved by lighterage on the outer side of a vessel. Much, of course, depended on the cargo. With a bulk cargo, such as sacks of sugar, it was possible to discharge cargo into sheds on the one side and into lighters on the other at the same time. The procedure would be difficult if the cargo consisted of different consignments.

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Mr. Gwyther and his firm preferred blocks of from 12 to 20 tons for the ordinary construction of wharfs. They used larger blocks, of 40 to 50 tons, in breakwaters. At Marseilles, blocks of 350 to 400 tons had been used in the outer breakwater of an exposed harbour. The particular case mentioned in the Paper was Mto Mtwara, where the contractors had tendered on the basis of 50-ton blocks; but, although a complete slice of wall was made up of five blocks, he was still convinced that it was the cheapest method. The use of large blocks required not only an expensive block-setting plant, but also expensive plant in the block yard to lift and move the blocks ; and it was necessary to have some arrangement for transporting them into position over the water. Fifty-ton blocks were not easily carried by rail, and the blocks had to be moved by water. That required a lifting appliance which would put the block on to a barge over water.

Sliced work was used where a settlement of foundations might occur. One reason why smaller blocks were favoured was that they were nearly always set with a crane travelling on sliced work already in position, and that helped the settlement of the work before the superstructure was put on. In the case of the floating contrivance, the blocks were put down without standing on the wall itself, and full settlement might take several years.

He agreed with Mr. Palmer that 100,000 tons was a better figure at which to consider departing from lighter berths and constructing deep-water berths. The rate of working of 15 to 20 tons per hatch seemed to be about right, and agreed with the figures for Singapore. With regard to Barbados, he understood that there were good prospects of the sale of reclaimed land, which would help to reduce the capital cost of building deep-water berths.

Mr. Lakerides had mentioned Lagos and the possibility of constructing the wall between piles. The quay at Port of Spain, Trinidad, where the foundation was on clay, had in fact been constructed between steel sheet piling, but the use of that method was determined by the type of foundation; it had the disadvantage that progress was much slower. The two lines of sheet piling had to be strutted, and the fitting and removal of struts took time. Furthermore, the pouring of concrete under water or in a pumped-out trench was a slower process than setting the blocks, which could be made on land and under supervision. In Lagos the foundation was fairly hard sand and presented quite a good foundation for sliced work.

The probable life of a concrete block wall could not be accurately stated, but he knew that a breakwater had been built at Portland (England) in about 1858-60 and the blocks were still in perfectly good condition. There was every reason to assume that a block wall had a life of a hundred years or more.

In reply to Mr. Marshall's enquiry regarding comparative records of cargo handled at Singapore, the following details had been supplied to Mr. Gwyther from Singapore.

In 1949, disregarding 500 feet of wharf taken up by coal-handling plant, about 2,500 vessels, with an aggregate net registered tonnage of nearly 7,000,000 tons, had used 11,500 feet of wharf, involving a total import and export cargo of approximately 3,500,000 tons. The tonnage of dry cargo passed over those wharfs had ranged from 415 tons at one wharf to 135 tons at another. In addition, nearly 250,000 tons of latex and palm oil had been imported at five of the wharfs. Rice imports, which were not included in those figures, were generally handled at lighter berths which could easily deal with 1,000 tons per day.

Mr. Farquharson, in a written reply, stated that double-storey sheds (the upper storey being used solely for exports and the ground floor for imports) were now generally preferred at deep-water berths at East African ports. The principal factors leading to the adoption of that policy were:

(a) Higher berth utilization could be obtained when the shore facilities were such as enabled one ship to follow another quickly.

(b) Adequate space for export and imports enabled a higher rate of loading and discharge to be achieved.

(c) The storage available for exports enabled movements by rail to be evened out, with consequent economies. (In that connection, it should be noted that practically all exports were carried by rail, mostly from distances which precluded consignments being dispatched to enable them to be handled direct from rail to ship.)

(d) The storage available for imports enabled rail traffic to be evened out during periods of heavy arrivals.

(e) Port handling costs were reduced by storing exports as near to the deep-water berths as possible.

(f) Most of the ships calling regularly at East African ports discharge and/or loaded considerable tonnages (usually about 1,000 tons or more) and those quantities could best be dealt with when adequate space for imports and exports was available close to the quay. Whilst that arrangement resulted in the upper storey being used to some degree as a storage shed, the administration retained the right, if the flow of goods was in any way impeded, to remove export cargo which remained too long in the sheds.

At Dar es Salaam, battery trucks would be employed for certain types of import traffic. It was intended to handle the export traffic by 1-ton overhead travelling cranes operating through the shed from the back platform, the goods being transferred from the upstairs platform by wharf crane.

In 1949, the general cargo tonnages handled per foot of quay at East African ports had been as follows:

Mombasa deep-water quay ...	375
Dar es Salaam lighter quay ...	385
Tanga lighter quay	349

All ports were working very close to capacity with delays to ships possibly above the level normally considered desirable. The new berths at Dar es Salaam would have facilities better than those in existence at Mombasa and it should be possible to handle about 400 tons per foot (240,000 tons per berth) without undue delays to shipping.

None of the East African ports had a system of navigable waterways, so that that factor was of no importance in determining the level of traffic at which deep-water quays should be constructed. Deep-water quays were usually built in units of about 600 feet and the cost could be justified only when a unit was to be used to good advantage. It appeared, therefore, that, if there were no special circumstances, it would be reasonable to provide one berth when the tonnage was approaching 200,000 tons. It was the policy to retain lighterage facilities in existence after deep-water berths had been built, so that they could be used for:

(a) handling cargo to and from ships discharging or loading tonnages so small as not to justify berthing;

(b) providing capacity when the deep-water quays were working at full pressure;

(c) dealing with special types of traffic;

(d) assisting in the discharge or loading of berthed ships when it was necessary to achieve especially rapid handling.

Terminal Requirements for Oil Tankers

At the World Petroleum Congress at the Hague last May, authors of more than one paper referred to the importance of adequate harbour facilities for oil tankers. Thus a Belgian paper pointed out that whereas passenger and dry cargo ports are selected because of their natural facilities, in the case of oil tankers, normally loading terminals are selected according to the operational needs of the oil producing companies, regard being paid to the proximity of the oilfield; and discharging terminals, for safety reasons, are usually sited well away from ports used by general shipping—where, incidentally the best harbour facilities exist. When tankers were comparatively small this mattered less than today, when capacity may be as much as 30,000 tons.

The authors of a British paper described facilities at ocean tanker discharging berths as ranging from the submarine pipe-line or short jetty to the large quay equipped with power-operated cargo hose cranes, shore steam supply lines and cargo pipe-lines. As an instance of problems met in practice, they mentioned tankers with two pumprooms for cargo discharging, one forward and one amidships: if they are moored to a short jetty, one set of discharge connections becomes completely inaccessible. Such examples, it was stressed, point the need for discussions between ship and shore interests.

Pre-Stressed Concrete for Structural Work

Its Application to Building Generally, and to the Gas Industry*

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SUMMARY

PRE-STRESSED concrete has, to some extent, come somewhat suddenly to the forefront in the engineering world, as though it were perhaps a new discovery, or possibly a panacea for the shortcomings of traditional methods. Neither of these suppositions, however, is correct, the basic principles having been developed slowly, but surely, over the last 64 years, while engineers are still in search of the ideal. Very considerable claims are made, however, in favour of pre-stressed concrete construction, and it is believed that these are not without foundation.

It is the object of this Paper to describe works that have already been completed, or are now in hand, so that the engineer may be able to assess the relative merits of each of the projects for himself, when compared with similar works carried out by more conventional methods.

Pre-stressed concrete has now been in use in various forms of construction for at least 20 years, although a very considerable impetus has been given to it in the post-war period, both by shortages of materials, particularly steel, and also by the inherent faith of those intrepid pioneers of the subject, and their ardent followers.

Conditions on the various works within the Gas Industry are generally more severe than those encountered in many other spheres, and the engineer is always desirous of improving the external fabric of the structures under his control so as to minimize the corrosion, deterioration, and disintegration so common.

On account of the state of compression induced in concrete by pre-stressed reinforcement, the cracks that are always present in reinforced concrete construction become almost entirely eliminated. Furthermore, in view of the high pre-stress necessary to outweigh the various losses due to creep, shrinkage, and elastic deformation, the concrete used must be of higher quality than has been required previously. These factors constitute a definite advantage to the engineer concerned with the design and maintenance of Gas Works plant. Other advantages to be expected are the considerable saving in steel and the reduced size of many structural members, accompanied by a saving in cost.

At present, this type of construction has been successfully used for piles for land foundations, fender piles and dolphins for river work, and gantries and open-frame trestles for supporting mains and services, in addition to its normal use in framed buildings and structures. More specialized types of structures have also been considered, and amongst these are circular tanks, including gasholder tank foundations, caissons and cofferdams, large diameter pipes, tunnels, and also purifiers. Before embarking on such projects the engineer should appreciate that pre-stressed concrete is a more precise form of construction than reinforced concrete, consequently needing greater care and supervision in the constructional stages. Standards and codes are not yet available to guide the engineer, and he is left to rely on his own experience and that of the firms specializing in the subject to ensure a satisfactory result. This should not deter one from forging ahead and grasping at the advantages which are offered.

INTRODUCTION

The making of cement and concrete was an art well known to the Romans, although, unfortunately, their secret was subsequently lost for nearly 18 centuries. Since its re-discovery, however, and patenting by a Yorkshireman, Joseph Aspdin, in 1824, the use of concrete has spread rapidly throughout the world, competing favourably with other materials in current use, such as timber, masonry and cast iron.

The introduction of reinforced concrete by the Frenchman, Monier, in 1861, gave a further impetus to the development of the new structural medium, which in time gradually replaced some of the earlier materials and later became a keen rival to structural steelwork.

Strange as it may seem, pre-stressed concrete was first conceived, in 1886, by the German, C. F. W. Doehring, about 19 years after the French engineer, Coignet, had exhibited reinforced concrete beams and arches at the World Exhibition of 1867. Where, however, engineers generally were quick to develop the new technique of reinforced concrete, they were slow to appreciate the great underlying principles of pre-stressing destined to evolve from Doehring's German patent.

A number of other patents for various forms of pre-stressed concrete were subsequently obtained during the next 40 years until in 1926, Freyssinet, the famous French engineer, gave the first practical solution to the problem of pre-stressing, and set this method of construction on a firm basis, enabling it to compete, both economically and technically, with other structural engineering processes.

A similar time lag, following the initial conception of pre-stressed concrete, was almost inevitable, since considerable advances in the technique of concrete making and the manufacture of steel reinforcement have been recorded during this period, without which pre-stressed concrete, as we know it to-day, would be practically impossible.

The pre-stressing of concrete is essentially a method of construction most efficiently and economically carried out when the respective materials, steel and concrete, are of the highest quality, and capable of sustaining the highest possible stresses.

At the present time the normal working stresses acceptable in these materials are low when compared with those required for the proper execution of pre-stressed work. For example, in normal building work, using concrete of a 1 : 2 : 4 mixture the maximum stresses allowed are 750 lbs. per square inch in the cement, and 18,000 lbs. per square inch in the steel, compared with in pre-stressed concrete maximum stresses of 1,500 to 2,000 lbs per square inch and 130,000 to 200,000 lbs. per square inch in the concrete and steel respectively.

GENERAL PRINCIPLES OF PRE-STRESSED CONCRETE

As its name implies, pre-stressed concrete is stressed before it is put into use. Furthermore, this stress is arranged to be approximately equal in magnitude and opposite in sign to the tensile stresses induced by the live and dead loads, so that the final stress in the concrete can always, and at all sections, be entirely compressive. This condition cannot be achieved, of course, without a considerable increase in the stress in the reinforcement.

Two distinct processes for obtaining the initial pre-stress are in use at the present time, and it is important that their differences should be clearly understood. These methods may conveniently be set out in tabular form thus:

(a) Pre-tensioning, where the reinforcing wires are stretched on a special tensioning bed to a pre-determined stress, following which the concrete is cast around the wires and left to harden. After a specified time the wires become sufficiently gripped by the concrete, and the ends of the wires projecting from the member may be cut off and the finished unit removed. See Fig. 1.

(b) Post-tensioning, where the concrete units are cast first with holes left, through which the wires are to pass. When the units have hardened sufficiently, they are placed together end to end, the wires threaded through, and subsequently stretched by jacks thrusting against the ends of the completed member. The stretched wires are

*Abstracts from a paper read before the Institution of Gas Engineers in November, 1950. Reproduced by kind permission.

Pre-Stressed Concrete for Structural Work—continued

finally anchored in special end anchorages and the whole cable grouted up to eliminate the possibility of internal corrosion.

(The sequence of operations described above is depicted in Figs. 2 to 6.)

Proprietory names covered by patents are associated with each of the above processes, the former being known as the Hoyer method, whilst the latter method has been developed by Freyssinet and Magnel.

It cannot be said at this juncture that one method is superior to another, but rather that they are complementary, each being the best within its own particular sphere of application.

The former method is essentially a factory process, whilst the latter method is applicable to work on the site, comparison between the two classes of work being closely linked with the relative merits of pre-cast and *in-situ* concrete work.

It will be observed that the reinforcement has been described as " wires," and not rods, as is customary in the field of reinforced concrete. Ultra high-tension drawn wire up to about $\frac{1}{4}$-in. in diameter is generally used with a maximum breaking stress of 100 to 110 tons per sq. in., although in some recent experiments medium high-tension rods of larger diameter have been used with some success.

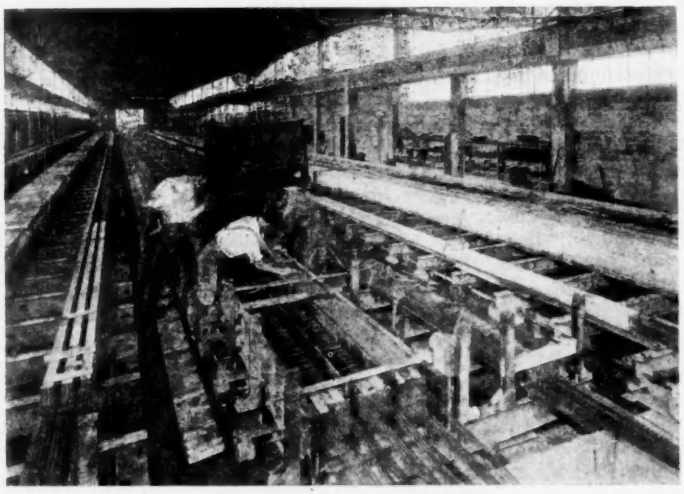


Fig. 1. Placing Concrete around Tensioned Wires.

The application of very high-tensile wire to the problem of pre-stressing was initially due to Freyssinet, who realized why earlier experiments at pre-stressing, using ordinary mild steel rods, resulted in failure.

When the steel wires are subjected to a tension force, creep takes place, which reduces the initial tension value, thus constituting a loss of pre-stress. Similarly, concrete in setting shrinks and, when subjected to a pre-compression due to the presence of the pre-stressing wires, is liable to creep also, these movements again constituting further losses in the pre-stress. It is found that these " losses " will entirely negative any pre-stress that can safely be given to mild steel. It is evident, therefore, that the higher the permissible working stress in the reinforcement, the higher the pre-stress, and the less serious the losses.

With the Hoyer system, these losses may constitute as much as 15 per cent. of the initial pre-stress, which is approximately 90 tons per sq. in.

With the post-tensioning system, the shrinkage and creep of the concrete are permitted to take place before the wires are tensioned, hence these factors do not reduce the pre-stress, which in this case is approximately 60 tons per sq. in. Incidentally, the conditions prevailing before the various losses in pre-tension take place, constitute the most severe loading the member is called on to sustain. The increase of stress in the steel reinforcement due to the live loading never exceeds that lost by the above factors, hence all members are actually stressed in excess of the design-

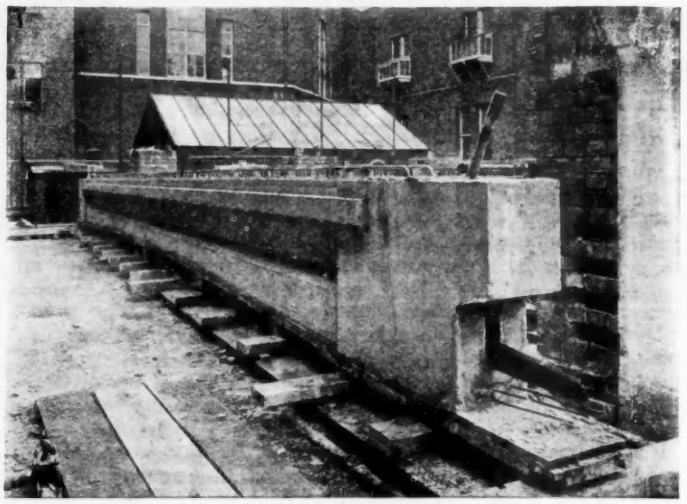


Fig. 2. Concrete Beam with Cable ready for Tensioning.

load stresses before leaving the factory of being accepted on the site.

The safety factor is not so generous as one is accustomed to use in normal reinforced concrete work. So far as the concrete is concerned a safety factor of three can be obtained under live-load conditions, whereas for the steel reinforcement the factor is $1\frac{1}{2}$ approximately. As the reinforcement is a factory made article, while the concrete may be a site product made under less rigorous conditions, these figures should give every satisfaction, particularly when it is remembered that the work, whilst undergoing pre-stressing, automatically tested in excess of the design conditions, as previously stated.

At the present time, no generally accepted code of practice is in existence controlling the manufacture or construction of pre-stressed concrete works. In fact, existing British Standards for the materials used, particularly for cement and aggregate, may

Fig. 3. Magnel Sandwich Plates fixed to End of Beam, preparatory to Tensioning Wires.

require revision to ensure higher quality materials to sustain the higher stresses adopted.

It would be considered singularly inopportune were such codes of practice to be published at the present time, and those engineers contemplating such a step would do well to remember that pre-

Pre-Stressed Concrete for Structural Work—continued

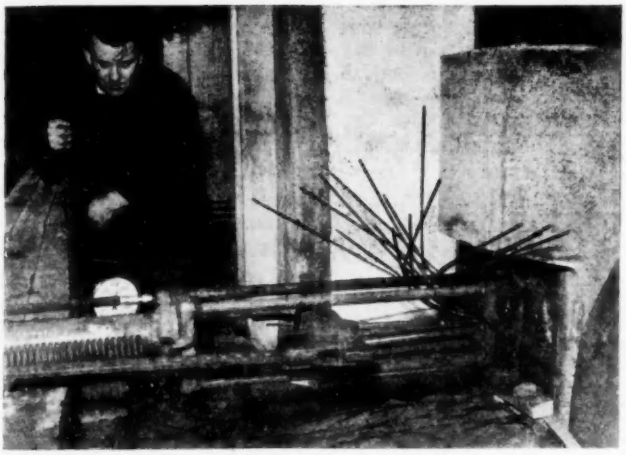


Fig. 4. Tensioning Wires by means of a Jack.

stressed concrete is still in its infancy, and the premature issue of restrictive codes would tend to halt new processes, stress increases, and other modifications, so prevalent and so essential to the proper development of the technique. Closer co-operation with responsible manufacturers and contractors can, in general, provide this necessary control over design and manufacture that the Engineer needs to ensure a satisfactory result.

One important point should be noted when approaching the subject of design. Pre-stressed concrete is not a modification or variation to reinforced concrete practice, but a new form of concrete construction requiring an independent and unbiased approach quite free of the conventions so well known and consistently adopted by the designers of reinforced concrete.

The use of pre-stressed concrete may be guided and influenced by similar structures already in existence. Unfortunately, it is not possible to look back more than 15 to 20 years, and in many

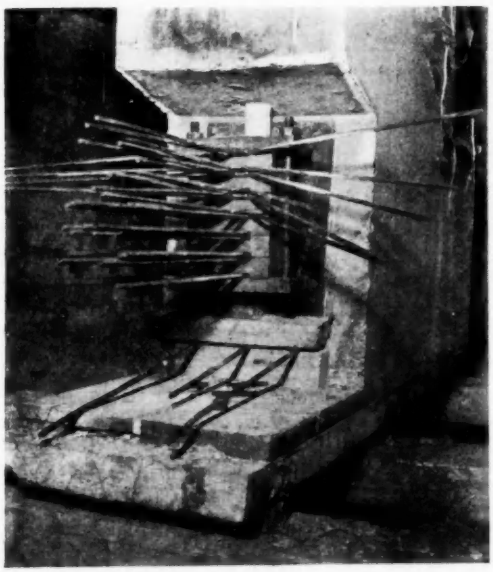


Fig. 5. End of Concrete Beam, showing some Wires Firmly Anchored in Magnel Sandwich Plates.

cases not more than five years covering the post-war period, when pre-stressed concrete in this country became more widely publicised.

ADVANTAGES CLAIMED FOR PRE-STRESSED CONCRETE

Fundamentally, the chief claim of pre-stressed concrete is that the nature of the material is virtually improved, the difficulties and disadvantages encountered in reinforced concrete work, due to the inherent weakness of concrete in tension, being eliminated.

It follows, therefore, that the whole section of a structural concrete member, whether beam, slab or column, which, as a reinforced concrete unit, may contain up to about 60 per cent. of practically non-load-carrying materials, now becomes effective in supporting the structure.

The size and weight of such a structure will inevitably be reduced, the saving in cost generally being greater than the extra cost involved in providing the pre-stress and the special reinforcement.

It is well known that concrete, surrounding reinforcement that is subjected to tensile stresses induced by the load, fails in tension before the full working stress in the steel can be realized. This is undoubtedly a serious disadvantage for structural work exposed to an atmosphere where industrial processes causes pollution. Minute hair cracks form in the concrete in the vicinity of the tension steel, these cracks giving access for moisture, laden with various injurious substances, direct to the steel reinforcement. The elimination of these cracks, due to the state of compression existing in the concrete at all sections, will minimize deterioration due to the above causes and prolong the life of the structure.

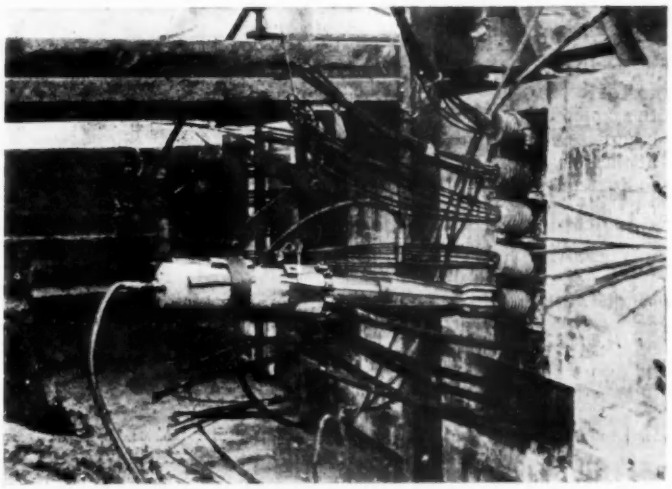


Fig. 6. Tensioning Wires by means of Freyssinet Jack and End Cones.

Owing to the high stresses used in pre-stressed concrete design considerable improvement in the nature of the concrete is expected. The use of vibration, and greater supervision in the proportioning of the materials, care in the use of water for mixing, and special curing devices, should all contribute to produce a higher grade concrete than one is accustomed to expect for normal reinforced concrete work. Permeability should accordingly be reduced and the density increased, and as a result of this the direct attack on the concrete by aggressive atmospheric conditions would be appreciably delayed.

Among the other advantages are the reduced weight of beams and slabs, due primarily to pre-stressing, though to some extent due also to the higher stresses adopted; the appreciable reduction in the amount of steel used, and the greater resilience under the action of impact forces. Arising from these points is the greater ease of handling pre-cast, pre-stressed members, due to their ability to withstand shock and sustain appreciable deflections without cracking.

As would be expected, the high-tensile reinforcement is considerably more costly than ordinary mild steel reinforcement, while the higher grade concrete is more expensive than normal concrete. A properly designed pre-stressed concrete structure is, however, considered in most cases to be less expensive than its conventional reinforced concrete counterpart.

At the present time, pre-stressed concrete is being applied experimentally to every form of concrete work ranging from fence posts to large-span bridge girders, and engineers should examine carefully the various schemes offered to them, to ensure that the

Pre-Stressed Concrete for Structural Work—continued

use to which pre-stressed concrete is put is justifiable and economical and not merely of publicity value. There is no doubt that very real advantages are obtained by the use of pre-stressed concrete in many spheres, but a word of caution is necessary as the technique is still in its early stages of development.

SOME APPLICATIONS OF PRE-STRESSED CONCRETE

Some of the various uses of pre-stressed concrete are listed below with details of their application to structural and building works within the Gas Industry. As might be expected, many of the applications described will be of wider interest also, and it is hoped that work of a pioneer nature may be of use to engineers interested in similar problems.

(a) Piles for Land Foundations

Preliminary tests on pre-stressed concrete piles were first carried out in May, 1949, at the Stanford-Le-Hope Works of the North Thames Gas Board. These preliminary tests are thought to be the first carried out in this country. They were extremely severe and it is no exaggeration to say that the piles tested fulfilled the tasks allotted with every satisfaction. The object of these tests was to determine the effect of age, reduced section, and pre-stressing on the handling and driving and ultimate strength of the piles.

The test piles were made on the Hoyer bonded wire system and were 10-in. square and up to 35-ft. in length. They were reinforced with four clusters of 2 mm. high-tensile steel wires, while the concrete mix was 1 : 1½ : 3 by volume, the minimum ultimate compressive strength of the concrete being 5,500 lb. per sq. in. at the release of the pre-stress, and 7,500 lb. per sq. in. at 28 days.

Extreme flexibility was observed during handling, which was carried out by single-point suspension, with the addition of a " snatch " test, where the pile was lowered and suddenly halted in mid-air. No sign of distress was observed during these tests.

To determine the strength of the head, a final driving test was carried out, using a 2-ton 16-cwt. hammer, falling between 4-ft. and 6-ft. The head under these conditions was ruptured, the pile having been previously driven to a set of 2-in. for 294 blows, or approximately 1/16-in. for 10 blows of 8-ft./ton energy each. The age of the piles varied between 10 days and two months, although it is not recommended that piles as young as 10 days would prove generally satisfactory at the present time.

Following the undoubted success of these preliminary trials, a small number of similar piles was specified on two contracts for the North Thames Gas Board at the Beckton works. Apart from a few minor troubles to be expected in the early stages of such

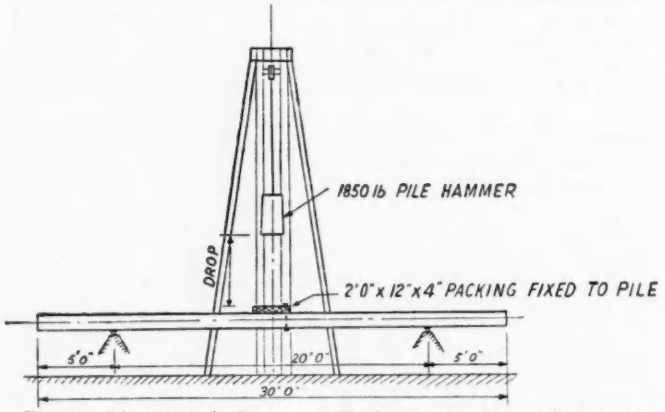


Fig. 7. Diagrammatic Layout of Equipment for Impact Testing of a 12-in. x 12-in. x 30-ft. Pile.

developments, these piles were driven satisfactorily, exhibiting the same main characteristics that were so evident at the Stanford-Le-Hope tests. As would be expected, a static loading test was called for to substantiate the claims made concerning their bearing capacity. In this instance a 10-in. sq. pile, 40-ft. long, was driven to a set of 2-in. for 10 blows of 7½-ft./ton energy each. No settlement was recorded until the test load exceeded 40 tons. When the load reached 75 tons the test was stopped and this load left in position for three days during which time an initial settlement of 0.3-in. was recorded this remained constant for the rest of the time that the load was maintained. It is not suggested, because in this case 10-in. sq. pre-stressed piles replaced 14-in. sq. normal precast piles, that their load-carrying capacity is the same. The carrying capacity of a pile is a function of its surface

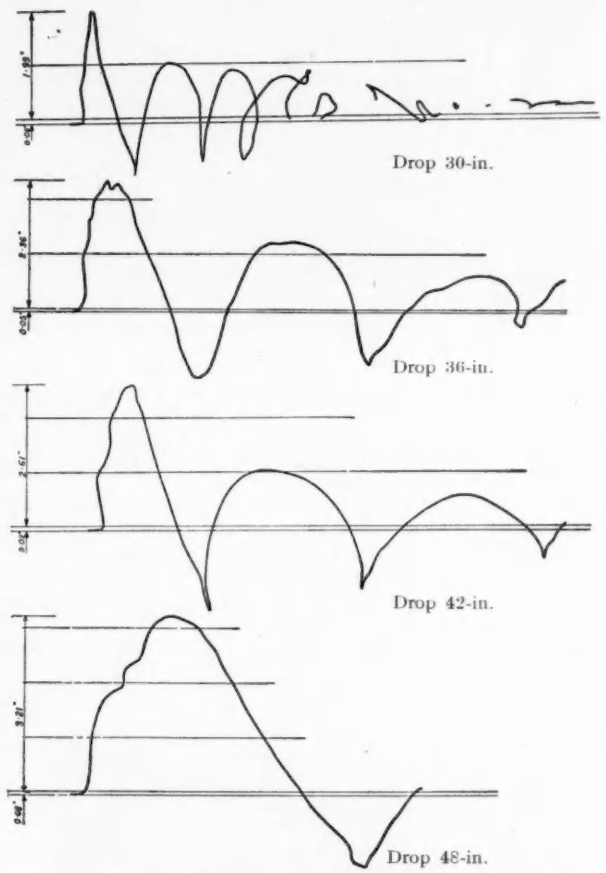


Fig. 8. Traces of Impact Test Oscillations for Drops ranging between 30-in. and 48-in. on a 12-in. x 12-in. x 30-ft. Pile (Mark "A").

area and cross-section, and obviously the larger pile must carry the larger load. This test, however, does raise a question as to whether at present many of the piled foundations provided are probably over-cautiously designed. Engineers cannot, however, cut their factor of safety indiscriminately, and must have proper evidence in support of any reductions contemplated. This is particularly so in regard to piled foundations, for which no two sites are the same, the ultimate resistances of the piles on one site alone differing appreciably in many cases. For this reason it is recommended that static loading tests, carried out to failure, should be considered where a number of piles are to be driven or where pre-stressed piles of smaller section are to be adopted.

It is hoped that, although only one static test has been carried out and described here, the results so obtained may be of use to engineers contemplating the use of similar piles.

The adequate bonding of pile heads into the superstructure is not quite so straightforward as with the conventional pile.

In place of the usual four rods, a " brush " of wires is exposed, which, if the pile be subjected to an uplift, requires very careful consideration.

Examples have already been designed where the pile head has been left intact, but well hacked and a considerable length embedded in the superstructure, thus relying on the mechanical bond to provide the necessary anchorage.

Pre-Stressed Concrete for Structural Work—continued

(b) Piles for River Work

Many large gas-making stations are situated near a river or canal where bulk supplies of coal can be more easily and cheaply handled. This feature inevitably raises the question of berthing facilities, jetties, piers and other associated works.

One of the main problems on such structures is the fendering necessary to protect the structure from the heavy impact forces from coal barges and ships.

Before constructing the fenders, which were isolated three-pile units, an impact test was arranged on specially manufactured pre-stressed fender piles considered to be suitable for the work contemplated.

A brief specification was prepared, by the Board, which is reproduced here.

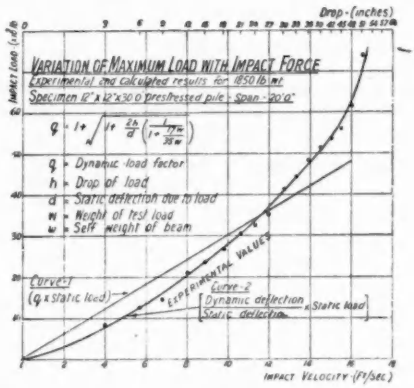

Drop-(inches)
Impact Load (Lbs)
VARIATION OF MAXIMUM LOAD WITH IMPACT FORCE
Experimental and calculated results for 1850 lb. wt.
Specimen 12" x 12" x 30'0" pre-stressed pile: Span-20'0"
q = Dynamic load factor
h = Drop of load
d = Static deflection due to load
W = Weight of test load
w = Self weight of beam
Curve-1 (q x static load)
EXPERIMENTAL VALUES
Curve-2 Dynamic deflection / Static deflection x Static load
Impact Velocity (Ft/Sec)

Fig. 9 (left). Graphs showing the Variation of Maximum Load with Impact Force for a Pre-stressed Pile 12-in. x 12-in. x 30-ft. over a 20-ft. Span and for 1,850 lb. weight.

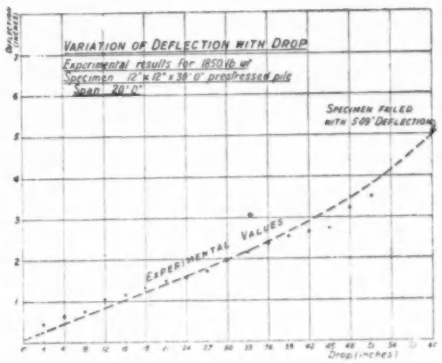

VARIATION OF DEFLECTION WITH DROP
Experimental results for 1850 Lb. wt
Specimen 12" x 12" x 30'0" prestressed pile
Span 20'0"
SPECIMEN FAILED WITH 5.69" DEFLECTION
EXPERIMENTAL VALUES
Drop (inches)

Fig. 10 (right). Graph showing the Variation of Deflection with Drop for a Pre-stressed Pile 12-in. x 12-in. x 30-ft. over a 20-ft. Span and for 1,850 lb. weight.

Specification for Impact Test on Pre-stressed Concrete Fender Piles

Test Specimen	...	Three specimens shall be tested. These specimens shall be 12-in. x 12-in. x 30-ft. long, reinforced to provide a maximum moment of resistance equal to 200,000 lb. per in. The concrete mix shall be 1 : 1½ : 3 by volume.
Test Span	...	The above specimens shall be supported symmetrically and truly level on two rigid knife-edge supports spaced 20-ft. apart.
Load	...	The specimen shall be subjected to impact loads produced by a 1-ton weight falling through varying drops, until failure is reached. The test load shall be truly plane on the lower face, and shall make contact with a short length of 12-in. x 4-in. timber securely bolted to the fender. The impact loadings may be made at frequent intervals as found most satisfactory.
Records	...	Full and accurate records shall be kept throughout the test, including contact measurements of the damped oscillations produced.

This work was carried out at the request of, and in close co-operation with, the Board by Concrete Development Company, Limited, at its works at Iver, Bucks. The specially designed fender piles were manufactured on February 18, 1950, and tested on May 9, 1950, test cubes revealing the following crushing strengths:

	lb. per sq. in.
Crushing stress at 3 days:	5,000
,, ,, 5 ,, :	6,400
,, ,, 7 ,, :	6,900
,, ,, 28 ,, :	8,300
Test:	9,000 (estimated)

The test weight used was actually slightly less than that specified, being 1,850 lb. weight.

The drop was varied by 3-in. increments, the static and dynamic deflections being measured at each impact.

An approximate trace of the dynamic oscillations produced following impact was recorded in each case, although it should be pointed out that the time base for each of these " oscillograms " was not calibrated. Taking into account the somewhat approximate nature of the test, it was not considered justifiable to call for elaborate measuring devices, and it was not possible, therefore, to obtain the period of oscillation of the pre-stressed members. No doubt research into this problem will be made, if necessary, in due course. The main purpose of the test was to obtain the ultimate dynamic breaking load of the fenders, and to study their resilience under loading which approximately simulated working conditions. The barges using the berthing facilities at Brentford do not at present exceed 350 ton displacement, with a loaded draught of 9-ft. 5-in., but, as is customary with river traffic, they do not come singly, but in groups, and approach the berth from all directions, also using the fenders as moorings.

The most usual method of analysing the problem of impact is based on the assumption that a heavy mass falls on to a weightless beam, the kinetic energy of the falling body being equated to the resilience of the beam. Development of this basic equality leads to an " equivalent static " load or " dynamic factor." The effect of the impact is then considered to be similar to that of a static load multiplied by the appropriate " dynamic factor," from which the " equivalent static " load can be determined.

If h is the height through which the weight falls, and d the central beam deflection due to the application of the static load, then the dynamic factor q is given by the following expression:

$$q = 1 + \sqrt{1 + \frac{2h}{d}}$$

If the weight of the beam be taken into account, a more rigorous analysis shows that:

$$q = 1 + \sqrt{1 + \frac{2h}{d}\,m}$$

where

$$m = 1 \Big/ \left(1 + \frac{17w}{35W}\right)$$

and

w = weight of beam.
W = weight of falling body.

In the particular case of fenders, the weight of the vertical member will not influence the deflection in the same way as for a horizontal beam. This latter expression has, however, been used in analysing and comparing the results of the test, since the fenders were tested in a horizontal position.

More exact theories exist, taking into account the variations of the resistance of the beam with deflection and the mutual compressibility of the bodies on impact, but, under the prevailing circumstances, such precision was neither considered justified nor able to contribute usefully to a problem in which so many other unknown factors exist.

Fig. 7 shows the test equipment and Fig. 8 are reproductions of the actual traces of the oscillations observed with varying drops up to a maximum of 60-in., when the unit broke.

An extremely valuable piece of research work has been carried out by Dr. R. N. Arnold.* This work describes, in detail, the impact stresses in a freely supported beam produced by falling bodies ranging from 50 to 470 lb. weight. In order that engineers interested in this subject may be able more easily to correlate the various curves, Fig. 9 has been prepared, in which the impact load is plotted against the impact velocity, for the tests described here, while Fig. 10 shows the variation of deflection with drop.

(to be continued)

*Arnold, R. N. Impact Stresses in a Freely Supported Beam. *Proc. Inst. Mech. Eng.*, 1937 (137), 217 to 281.

The Projected Grand Contour Canal

Water Supply and Navigation of the "Cotswold Arm" and the "Buckingham Arm"

By J. F. POWNALL

EDITORIAL FOREWORD

THE Grand Contour Canal* projected by Mr. Pownall would be a work of very considerable magnitude, and if constructed, would form a single level water route at the uniform height of 310-ft. above sea level, serving London, Bristol, Southampton, Birmingham, Manchester, Leeds, Newcastle and other centres of industry. Many of the existing canals would become branches of it, and traffic would be passed to and fro by means of locks and barge lifts. The advantages of canals of large section are well known, and in Mr. Pownall's proposals this is met by a width of 100-ft., a depth of 17-ft. and a minimum headroom of 25-ft. The waterway would thus accommodate coastal and estuarial craft of fair size, and with its connections to estuaries and other large rivers, could be regarded as one system.

It is also envisaged that the Grand Contour Canal would intercept certain drainage of areas of land lying at a higher level above its course. It would thus form a catch-water canal and act as a conduit for distributing the rainfall. In times of copious flow, water would be passed down to the permeable areas lying below the canal level, to replenish those streams, ponds and ground water storage, which are now being over pumped, especially in the Midlands and London areas.

In the present article, Mr. Pownall discusses the possibilities of initially constructing two sections of the proposed Grand Contour Canal, which he has named the "Cotswold Arm" and the "Buckingham Arm." While the case for this project, limited in scope compared with the entire scheme, is primarily based on the supply of water to London, it would undoubtedly be a useful addition to the internal waterway facilities of the country. Authoritative opinion is almost unanimous in opposing capital expenditure upon new navigations in England at this time. However, if the capital cost of constructing new canals could be justified by a certain return from the sale of water, there would not be the same objection and then the facilities offered would be welcomed by water transport interests.

INTRODUCTION

There are two distinct projects in view. The first is to construct the "Cotswold Arm" of the Grand Contour Canal and to use it to store upper Thames floodwaters in the Oolites. The second project is to construct the "Buckingham Arm" extending eastwards, and further works, which will enable Severn water to be brought right across country to North London.

These two projects would secure the required major water supply for London, and a further great supply for market garden irrigation, whilst an important navigation link would be secured.

"THE COTSWOLD ARM"

General.

The Cotswold Hills lying to the north-west of Oxford form an extensive tract of high lying country. The formation comprises various limestone beds including the noted Oolite limestone, parted by clays and marls. The limestones absorb and hold underground large quantities of water which reappear in numerous springs to nourish the head streams of the Thames: the Windrush, the Evenlode, the Colne and the Churn.

There would be no gain in disturbing the underground water which reaches the Thames anyway, and in a naturally regulated flow. The present project therefore is concerned with recovering floodwaters which are on the point of leaving the district, and holding these waters by developing underground storage in strata which are not now effective as natural regulators.

Permeable beds which can be so used are found by following the Oolites to the south-east. In this direction they dip under the succeeding thick Oxford clay which pens in the contained water. In fact, as is often the case with stagnant water it gradually becomes saline as the beds are followed downwards. The upper Thames Valley is on the Oxford clay and the line of outcrop of the Oolites from the clay runs roughly parallel to the Thames and a few miles to the north.

The Works Proposed in Outline.

The Grand Contour Canal as projected skirts the southern margin of the Cotswolds, and maintains there, and throughout the system, the uniform level of 310-ft. above sea level.

It is proposed to construct a reach to be called the "Cotswold Arm" of this one level canal from Poole Keynes (near Kemble) to a point by the Evenlode, one mile south of Stonesfield, and to construct feeders thereto, to intercept the floodwaters of the Churn, Colne, Windrush and Evenlode. The line of this reach follows closely the outcrop of the uppermost limestone of the Oolites, the Cornbrash, and is well placed to pass water into the porous beds which underlie the Oxford Clay. It will further be proposed that floodwaters of the upper Thames itself, including the waters brought by the southern tributaries, the Ray and the Cole, be led by a conduit from the Thames at Radcot to Witney, there to be pumped about 90-ft. to the 310-ft. level of the Canal.

At various points along the "Cotswold Arm" works will be constructed to apply the floodwaters to the permeable strata intended to receive them. Very probably the closely adjoining Cornbrash, which is a well jointed and receptive limestone, would be used as a natural filter. The coarse silt will have settled in the canal itself.

The stored water when required in a dry season can be drawn upon by a line of boreholes ranged along the upper Thames, and if required for supply to London, simply passed down the Thames. The difference of level between 310-ft. and Thames-side levels of 220-250-ft. adjoining suggests that it may be possible to establish artesian pressure, with the effect of minimising pumping. This may still more favourably apply to wells sunk at Abingdon at the yet lower level of 160-ft.

Estimate of Floodwaters Available.

The type year is taken to be that from October 1st, 1936, and as a working assumption it is taken that the Cotswold streams can be drawn upon heavily when the flow over Teddington Weir is more than four times the long period average flow. This occurred on 36 days during the year in question, which was rather wetter (about 16%) than the average. The total catchment area of the first project is about 560 square miles or one-seventh of the total area of the Thames basin. One-seventh the flow over the weir on the 36 days yields a quantity of water, which after allowing that an approximately normal flow should remain in each stream past the intake, would amount to about 30,000 million gallons, or rather more than half of what would have been stored by the Enborne Reservoir, the scheme for which is now shelved.

Estimate of Underground Storage Attainable.

The most promising water holding beds are those of the Great Oolite series (see the geological section) which average round about 100-ft. thick. Estimating their average porosity at 10% by volume, and further considering the storage area to underlie, roundly, 25 miles along the 310-ft. canal and four miles to the south thereof, then the storage realisable according to these figures would be 174,000 million gallons.

The nearly six-fold extent to which this storage capacity exceeds the water abstraction of a good rain year is important in enabling

*A review of the Projected Grand Contour Canal appeared in the June 1942 issue of this Journal.

Projected Grand Contour Canal—continued

Fig. 1. Map showing proposed Grand Contour Canal System and Connections.

a reserve to be built up during a run of wet years to meet the contingency of a run of dry years.

Value of the Water Annually Abstracted.

The retail value of the 30,000 million gallons previously estimated as the annual abstraction would at 1s. 3½d. per 1,000 gallons, which is the average charge of the Metropolitan Water Board, amount to £1,900,000. The quantity of water is equal to about 24% of the present annual supply of the M.W.B.

The market for this water would lie between the Metropolitan Water Board, which could take a steadily increasing quantity, and irrigation for intensive cultivation, for which there is scope for great development. It is suggested that a reasonable bulk sale price would be indicated by the debt charges which the M.W.B. at present incur of 4s. 3d. in every £1 paid in water charges. If then the bulk sale price was comparable to this, say 4s. in the £1, then that price would be about 3d. per 1,000 gallons.

At this latter price the sale of an annual 30,000 million gallons would yield £375,000.

Constructional Particulars.

The "Cotswold Arm" would be constructed as a section of a first-class modern navigable canal, with cross section dimensions as laid down for the Grand Contour Canal which is proposed to be 100-ft. wide and 17-ft. deep. The material to be excavated is limestone in beds of varying hardness parted by beds of marl or clay. By shot firing, such material for the most part would probably loosen sufficiently for it to be taken out with powerful shovels. The quantity as calculated from longitudinal profiles would be 12 million cubic yards, and at 4s. per cubic yard this would cost £2,400,000.

Land and compensation for the 26½ miles length of the reach will be put at £800,000.

The road overbridges initially provided would be temporary structures spanning only 30-ft. This narrowing of the canal at the bridges will not matter whilst navigation traffic along it is light. There are some 46 bridges and at £10,000 each the total cost would be £460,000.

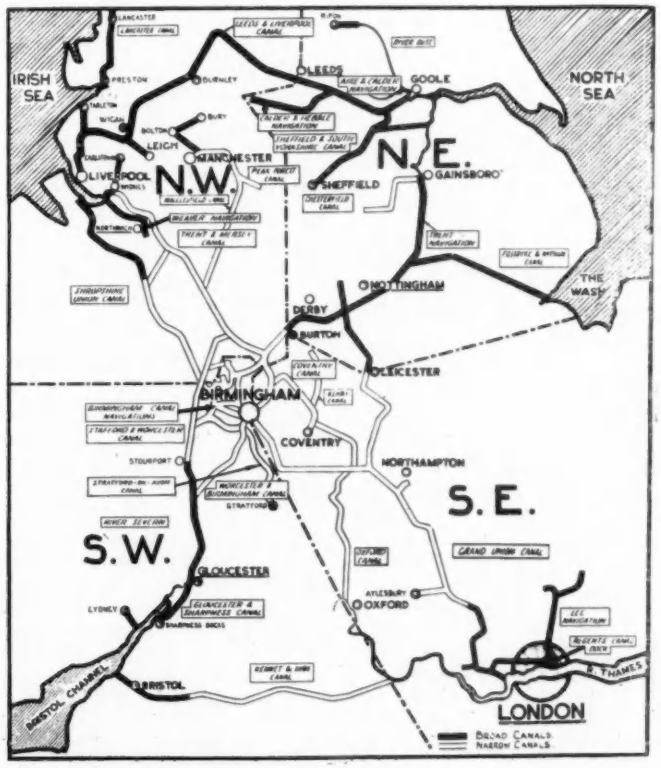
Some 12 miles of feeder canal required, estimated at £50,000 a mile, total £600,000.

SUMMARY OF COSTS*	£
Earthworks	2,400,000
Land	800,000
Overbridges	460,000
Feeder Canals	600,000
Works for underground storage, allow ...	1,000,000
Contingencies, allow	500,000
Parliamentary and Consulting Engineers ...	200,000
Total	£5,960,000

*This article was originally drafted in 1949. The figures quoted should be taken as relative, being subject to adjustments consequent upon the rise in costs since that date.

Financial Return to be Expected.

Four per cent. of the above estimated cost would consume £240,000 annually as interest on capital. Operating costs would be relatively moderate, as is usual for well constructed waterways, but would be probably of the order of £200,000 per annum. To meet these charges and provide a reward for risks, there are the sale of water suggested as yielding £375,000 per annum, and navigation tolls. These latter would be very small whilst the "Cotswold Arm" remained an isolated waterway but would become large when, as part of the complete system, it formed a section of important routes.



Map showing existing canals with present administrative areas, for comparison with the suggested Contour Canal.

Projected Grand Contour Canal—continued

Engineering Considerations.

Two courses are open to a canal engineer, to excavate in the dry or in the wet. The latter course would be to use powerful floating units for excavating and concreting as far as can be contrived. It would be the policy to develop economical large-scale methods to serve for the main constructional programme of the Grand Contour Canal.

increases as the strata are followed deeper. This water would have to be withdrawn—which would be a great operation—and disposed of into the tidal Severn, using artificial channels all the way. For this purpose the Thames and Severn Canal, with the old Sapperton tunnel and the Stroudwater Canal are now available but the proposed Stroud extension described later, would be better as involving less pumping by 50-ft. of the head.

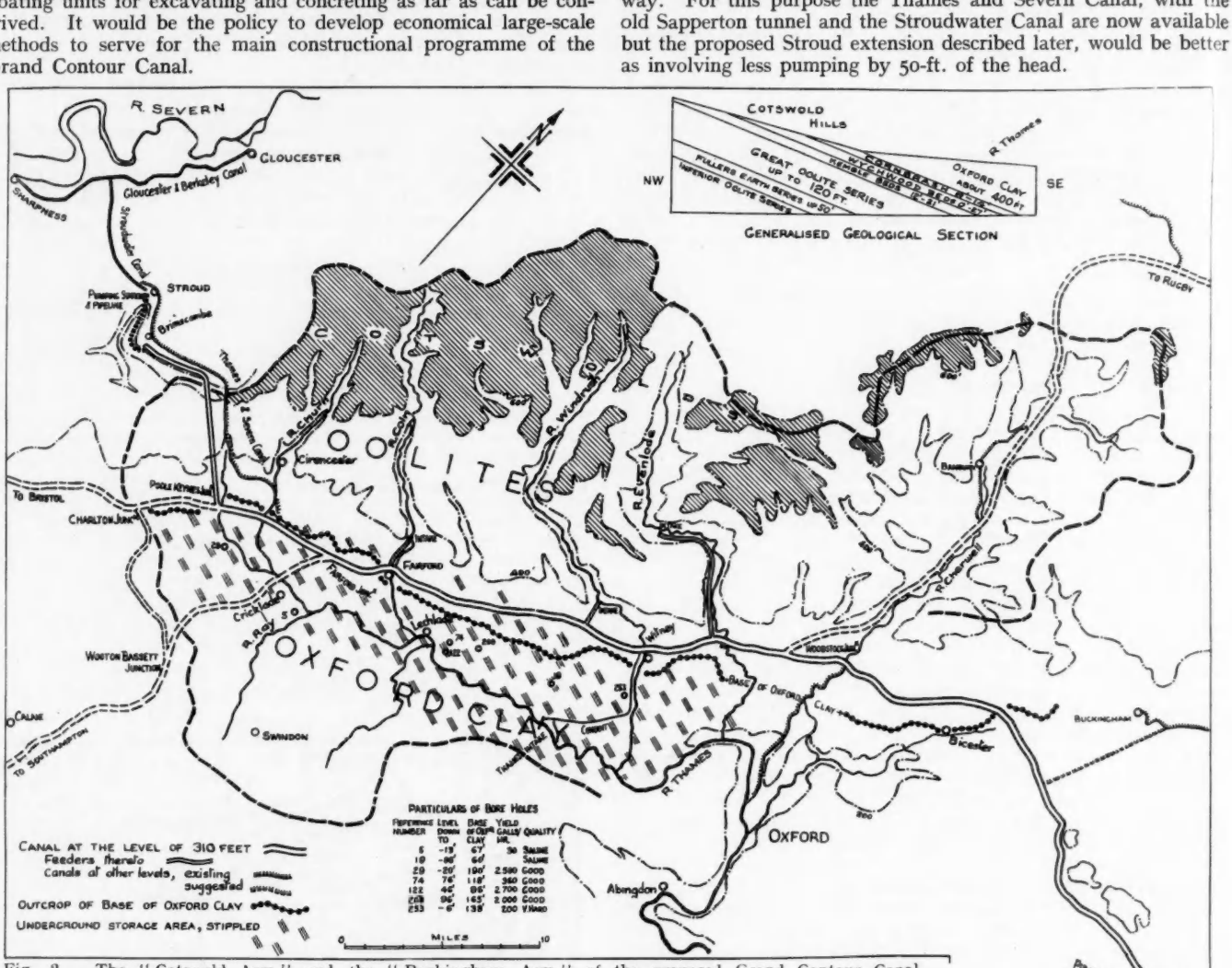


Fig. 2. The "Cotswold Arm" and the "Buckingham Arm" of the proposed Grand Contour Canal System. (NOTE: The "Cotswold Arm" would run from Poole Keynes Junction to the Evenlode Feeder. The "Buckingham Arm" would run from the Evenlode Feeder to join the Grand Junction Canal near Aylesbury. The Stroud Extension would run from Poole Keynes Junction to Brimscombe.

The detail planning of the scheme for underground storage would be a very considerable undertaking, which would require extensive underground exploration by trial borings, and in the planning there would be opportunist exploitation of any favourable features. Floodwaters as abstracted from the streams would be turbid. The coarse silt would settle readily in the 310-ft. level canal whence it would be cleared from time to time. There would remain algae and fine clay to raise difficulties, when it is sought to pass such water down into underground rocks. An ordinary bore hole, for instance, would soon be clogged up by the formation of a scum. Filtration in some way will be necessary unless a stratum is found which is so open jointed as to absorb surface waters without pretreatment. But if such a rock permits very free underground flow, filtration may still be necessary to prevent pollution affecting existing borehole users.

It may be observed that very large quantities of limestone would be available for disposal from the excavation of the canal: this spoil could be crushed to chips which might be formed into beds whereby surface waters might be applied over wide faces of natural rock.

In parts of the storage area the water is saline and the salinity

"THE BUCKINGHAM ARM"
and other extensions to the "Cotswold Arm"

General.

This project would extend the waterway of the first project, the "Cotswold Arm," by further reaches of canal at the level of 310-ft. eastwards and westwards, the "Buckingham Arm" and an extension to the Severn. These works supplemented by some pipe line and conduit would enable water pumped up from the Severn to be conveyed to the northern parts of London, there to augment the Metropolitan supplies.

The special merit of this project so far is that, though the water must initially be pumped to a high level from the Severn, it is thereafter conveyed at a high level throughout and the cost of a second high lift pumping, as from the lower Thames, is not incurred.

With the extended system navigation assumes great importance and interest.

The Works in Outline.

The "Buckingham Arm" would be constructed as a full standard reach of the Grand Contour Canal, and would continue from

Projected Grand Contour Canal—continued

the east end of the "Cotswold Arm" near Stonesfield some 38 miles to Cheddington where there would be a junction with the Grand Union Canal. The Stroud extension of the "Cotswold Arm" westwards from Poole Keynes to Brimscombe near Stroud would constitute a minor branch, the Stroud Arm, of the Grand Contour Canal, and would be constructed to reduce standards as regards navigation.

These several reaches of canal would together make an uninterrupted pound of water 72 miles long from Brimscombe to Cheddington, north of Tring.

The Severn becomes tidal at Gloucester and abstraction there can affect no downstream interests. From Gloucester the water can be passed along the commodious waterway of the Gloucester and Berkeley Canal, an old style ship canal, to the point where the Stroudwater Canal enters it, and then along that canal, widened perhaps. Thereafter a pumping station with a pipe line will be necessary to raise the water up to the 310-ft. level at Brimscombe. From Brimscombe the water will gravitate along the level canal with an inappreciable fall to the eastern end of the "Buckingham Arm." From here water would be conveyed by a pipe line to Aldenham Reservoir, distant 25 miles. The pipe line would be laid alongside the existing canal over Tring Summit, and this would involve pumping from 310-ft. to about 380-ft. Aldenham reservoir (Grand Union Canal) has a top surface level of about 325-ft. which would be convenient for a service reservoir for the northern parts of greater London which are largely of a comparable height.

Estimate of Water Available in Time of Drought.

It is taken that the flow past Gloucester and available for abstraction there will hardly ever be less than 300 cusecs, which is, of course, a very small fraction of an ordinary flow of the River Severn. If there is a winter of deficient rainfall, and if to conserve Thames storages abstraction of 300 cusecs is carried on for 150 days, approximately 25,000 million gallons will have been obtained.

The remoteness of the Severn headstreams from the Oxfordshire countryside is a favouring feature—it can be raining on Welsh hills and maintaining the flow in the Severn whilst the lands along the 310-ft. canal are dry. For instance, at Oxford in 1936, there was a dry spell lasting 25 days from April 27 to May 21 with no rainfall, and .42 inches for May, whilst at Newtown in Montgomeryshire there was 2.20 inches for May. The Severn flow never fell below 1,000 cusecs during May. Such a case is quite usual, for rainfall in the western districts is steadier as well as heavier, and drought falls more hardly on the eastern areas than the proportional rainfall would suggest. There would therefore be a large field for useful abstraction for agricultural purposes.

Navigation.

The 76-mile long reach without a lock would be attractive for navigation. The western end would connect with the Severn by barge lift down to the lower portion of the old Thames and Severn Canal at Brimscombe, below which the old locks took vessels 70-ft. by 15-ft. 6-in. by 5-ft. draught. Another barge lift, sited at the Cherwell Aqueduct called for on the 310-ft. level near Tackley could descend to the Oxford Canal, 80-ft. lower, which connects to the Thames, and might in this section be moderately enlarged to take Thames barges 17-ft. wide. Thus the old Thames—Severn connection would be restored. The connection of the 76 miles level to the Grand Union Canal at Cheddington would establish a direct route from London to the Severn.

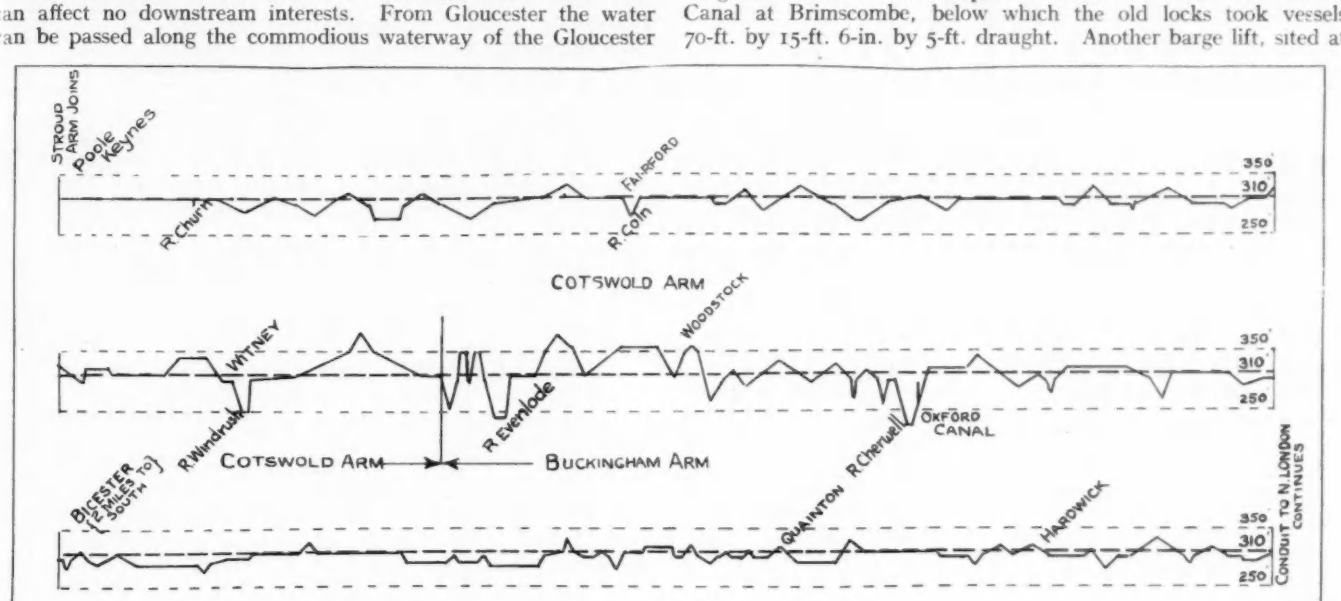


Fig. 3. Longitudinal Profile of earthworks for those sections of the proposed Grand Contour Canal dealt with in this article. The canal is at a uniform level of 310-ft.

Perhaps the significant aspect of the limited navigation of the "Cotswold and Buckingham Arms" would be the development of the hinterland of the Avonmouth and Bristol Channel ports. The country served is rural and large industrial development is unlikely. For coal, fertilisers and feeding stuffs it would look specially to the western ports, given the cheap through waterway. It would therefore be important that the works on the descent from the 310-ft. level to the Severn should admit vessels that can live in the estuarial waters below Sharpness. The 19 old locks below Brimscombe would need to be examined to see what improved width would be feasible if they were remodelled.

The complete scheme for the Grand Contour Canal provides for the continuation of the "Cotswold Arm" to Bristol and for a lift to sea level taking 1,500-ton vessels. That would be a great work. A lift of intermediate standard, say 300 tons, could be sited at Rodborough by extending the Stroud Arm thereto in tunnel, and the descent would be about 200-ft.

Feeders to the 310-ft. level canal would be of small cross-section but should be navigable to some degree. As conduits to transmit flood water at times they should be at least over 20-ft. wide and relatively deep so that an occasional barge could scrape through. But for freer navigation of constricted waterways by a craft which

Projected Grand Contour Canal—continued

yet reaches the standard of 100 tons, the writer suggests a vessel which is the present familiar narrow boat increased in scale in the ratio of 1½ : 1. The dimensions so arrived at would be about 108-ft. long by 10-ft. 6-in. beam by 5-ft. draught, these dimensions are also such that existing narrow boat canals of lesser importance could be adapted fairly economically to them, by enlarging the locks though retaining some of the existing overbridges.*

Operational Navigation.

We have so far considered navigation for the ordinary transport of merchandise, etc. But there is another sphere of navigation in which the waterway is used as an operating base. The operation of a floating crane in a system of docks is an example of this. The famous show boats on the Mississippi provide another case. The 310-ft. level canal would float mobile constructional units to assist in its own construction, as already noted. Such units, once available, would cheapen heavy industrial building on canalside sites; and this is also a potentially valuable development for dock estates.

Intensive Cultivation.

It is the group of services available along the 310-ft. level canal that would have special point for intensive agriculture. They are : the provision of water for irrigation, the extremely cheap transport of fertilisers, compost and other soil building materials, in large barges, the cheap and smooth transport of produce, doubtless in smaller barges and boats, and the facility of services by large mobile units such as for grass drying.

Water would be specially easily distributed over land which lies in a gentle slope declining from the canal and there are approximately 50,000 acres so disposed below the "Cotswold and Buckingham Arms."

Constructional Particulars.

The "Buckingham Arm" on the whole follows a very easy contour as the Profile of Earthworks shows. The aqueduct over the Cherwell would be a high bank formed from the surplus material excavated along the line. There will be several deep cuttings, due mainly to the choice of a line which will avoid mutilation of Blenheim Park, but elsewhere the earthworks are of a very easy character.

SUMMARY OF COSTS

For the "Buckingham Arm" of the Grand Contour Canal.

This reach is 33 miles long.

	£
Earthworks	3,600,000
Land	1,100,000
Overbridges	800,000
Contingencies	1,000,000
Parliamentary and Consulting Engineers ...	300,000
Total	£6,800,000

For the "Stroud Arm" of the Grand Contour Canal.

This arm is 12 miles long and would be constructed to minor standards as regards navigation.

	£
Eight miles of minor canal in open ...	800,000
Four miles in tunnel	1,000,000
Lift for barges at Brimscombe	200,000
Contingencies, etc., included in above ...	
Total	£2,000,000

Works exclusively for water supply purposes.

	£
Pumping station and other works Severn to Brimscombe	1,000,000
23 miles of 10-ft. dia. pipe or equivalent conduit by Tring to Aldenham ...	2,000,000
Total	£3,000,000
Grand Total	£11,800,000

*It has been suggested that alternatively, the locks which would be necessary should have dimensions of 92-ft. by 15-ft., thus accommodating a pair of narrow boats, or a barge of about 100 tons capacity. Such dimensions would correspond with those on the Trent Navigation and the "standard craft" proposed by Sir Osborne Mance.

Financial Prospects.

If the 25,000 million gallons estimated were supplied annually to London for a charge in favour of the Canal of 3d. per 1,000 gallons the revenue would be £312,500. Of this one-third would be required to cover pumping costs, leaving a net figure of roundly £200,000; enough to cover interest charges on £5 millions. This would leave some £6 millions capital requirement of the "Buckingham Arm" to be financed on the basis of navigation and irrigation charges.*

The projected "Buckingham Arm" and the other works accompanying it, have been put forward as continuations of the first and pilot scheme, the "Cotswold Arm," and thus merge into the considerations of the latter project.

*Whether sufficient revenue from traffic would be forthcoming to meet the charges upon this capital and the maintenance costs must be a matter for speculation.

OFFICIAL APPOINTMENTS.

THE MELBOURNE HARBOUR TRUST COMMISSIONERS.

APPLICATIONS, addressed to the Secretary, are invited for the undermentioned positions. Salaries quoted are actual including cost of living allowances, etc.

Appointees are eligible for Superannuation benefits after six months' service and long service leave after 20 years' service.

Applicants should state full name, age, educational qualifications, experience, present employment, war service (if any), and enclose copies of testimonials.

Conditions of appointment may be obtained from Messrs. A. E. Turner & John Coates & Co., Ltd., Victoria House, Melbourne Place, Strand, London, W.C.2, with whom applications should be lodged not later than 2nd November, 1951.

CONSTRUCTION ENGINEER.

Salary £1,300 per annum.

Applicants must possess a University Degree or recognised Diploma in Civil Engineering and have had experience in the organisation and supervision of Civil Engineering works, including pile driving, construction in reinforced concrete, steel, and heavy timber and construction of roads in reinforced concrete, bituminous concrete and macadam.

SENIOR DESIGNING ENGINEER.

Salary £1,100—£1,400 per annum

(according to qualifications and experience).

DESIGNING ENGINEER.

Salary £800—£1,050 per annum

(according to qualifications and experience).

Applicants must possess a University Degree or recognised Diploma in Civil Engineering and be capable of designing structures in steel, reinforced concrete or timber. Experience in harbour works is desirable.

A. C. COOK,
Secretary.

GREAT YARMOUTH PORT AND HAVEN COMMISSIONERS.

ENGINEER.

APPLICATIONS are invited from Civil Engineers for the position of Engineer to the Commissioners.

Applicants should have a thorough knowledge of Harbour and River work, including reconstruction and maintenance of Quays, Piers, etc.

Salary according to experience.

Applications, with testimonials, should be sent to the Clerk to the Commissioners not later than 10th November, 1951.

L. A. COLEBROOK,
Clerk.

21, South Quay,
Great Yarmouth.
4th October, 1951.

QUALIFIED CIVIL ENGINEERS, age 25-30, with varied site experience of heavy civil engineering works, preferably with a contractor, required for contract planning in London Head Office. Apply, stating age and full particulars of experience, to: Planning Dept., George Wimpey & Company, Limited, Hammersmith Grove, London, W.6.